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SOLID WASTE GARBAGE
AND OTHER THINGS
An L.I.P. RESEARCH PROJECT
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URBAN/MUNICIPAL

SOLID WASTE, GARBAGE
AND OTHER THINGS.

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An L.I.P. Research Project

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INTRODUCTION

It has been forecast that by 1980, over 80% of Canada's population will be urban dwellers. This would not appear to be much of a problem until one realizes the uneven distribution of that population. For example, two thirds of Ontario's population will be living in what is sometimes called the 'Golden Triangle', an area bounded by Oshawa in the east, Niagara Falls in the south and Kitchener-Waterloo in the west. Problems facing this area now and in the next few years were forecast by planners and engineers over ten years ago. They warned of urban sprawl and uncontrolled industrial expansion encroaching on precious land such as the Niagara Fruit Belt, the escarpment and other areas, the increasing water and air pollution associated with this type of growth, and the overall deterioration of the regional environment. However, few ever mentioned another rapidly growing problem which faces any urban conglomeration and the phenomenon is called solid waste. What does one do with it? At present, 4.5 pounds per capita per day is generated. By 2000 that figure is estimated at 7.5 pounds per capita per day. That's a lot of waste!

As defined by the United States Environmental Protection Agency, solid waste is "those unwanted residues of used natural or man-made resources and of human activities which are managed and handled in the solid state." In his report on Municipal Solid Waste, P.R. Flockton divides waste into four basic categories: i) Mining, ii) Agricultural, iii) Industrial, and iv) Household, Commercial and Institutional. In 1970 the proportion of solid waste in Canada which each of these types represented was as follows:

TABLE I SOLID WASTE GENERATED IN THE U.S. AND CANADA IN 1970

<u>Types</u>	<u>Millions of Tons per Year</u>	
	Canada	U.S.A.
Household, etc.	17	250
Industrial	11	110
Agricultural (excluding animals)	55	550
Agricultural (animals)	150	1500
Mineral	440	1100
Total	673	3510

This report will deal basically with domestic waste. Although, as one can see from Table I it is a small part of the total solid waste picture, it is this aspect which usually receives the most attention. Everyone contributes his share to domestic waste and everyone has to do something to get rid of it. And one always notices more in the urbanized areas. In the metals section we examine the industrial aspects because as Hamiltonians we felt it necessary.

As can be seen from Table II, domestic waste can be almost anything.

TABLE II APPROXIMATE COMPOSITION OF DOMESTIC WASTE

<u>Material</u>	<u>Percent by weight - dry basis</u>		<u>Total</u>
	<u>Sub-Item</u>	<u>%</u>	
Metals	---	---	8.3
Cloth	---	---	3.6
Plastics	Polyethylene	1.25	3.1
	P.V.C.	1.00	
	Polystyrene	0.65	
Rubber	---	---	1.0
Glass	---	---	8.3
Wood	---	---	2.0
Garbage	Food Waste	11.7	53.0
	Garden Waste	3.8	
Paper	Stationary	2.88	
	Books and Magazines	7.0	
	Newsprint	9.75	
	Brown Wrapping	5.77	
	Cardboard	24.0	
Inerts	Miscellaneous	3.60	5.2
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TABLE OF CONTENTS

	Page
Solid Waste Disposal Methods	
Dumps.....	2
Sanitary Landfill.....	3
Compost.....	8
Incineration.....	23
Incineration With Heat Recovery.....	26
Pyrolysis.....	30
Recycling, Re-Use and Reclamation.....	35
Paper	
General Issues.....	44
Discussion of Cities.....	50
Paper Companies.....	61
The Issue of Recycling	72
Metals	
Beverage Can Issue	78
Scrap Metal	83
Glass	
Introduction.....	89
Solid Waste Disposal of Glass.....	90
Reduction at the Source.....	98
Beer, Wine, Liquor and Juice Bottles.....	104
Appendix I.....	107
Appendix II.....	108
Plastics	
Introduction.....	113
Biodegradation.....	115
Plastics in Packaging.....	117
Solid Waste Disposal Methods.....	120
Japan	127
Packaging.....	131
The Task Force on Solid Waste.....	137
Overall Recommendations.....	142
Bibliography.....	143

SOLID WASTE DISPOSAL METHODS

In the past, little attention was ever paid to the disposal of solid waste in any area. That philosophy of dumping and forgetting is still carried on to some extent today. As a result, the technology of solid waste lies far behind any other phase of industrial or municipal priorities. The sacrificing of the environment in favour of a minimum expenditure operation has always been part of the system. It means less taxation for the people and maximum benefit costs for industry.

There is a psychological side to solid waste also. Since we are looking basically at urban generated waste the word garbage has to come to mind. The usage of the term garbage even has negative connotations attached to it. Who would ever want to be a garbage man? However all that is changing. Solid waste sounds better. Junk men are now called salvagers or recyclers. Some are saying that perhaps we shouldn't even look at refuse as solid waste. Some like the idea of a closed system of re-processing and reuse. There are statements pouring forth such as "trash is our only growing resource" or "there is wealth in waste."

Anyone who is concerned about the environment realizes that the above statements can be considered true to some extent. However, the question is one of changing our priorities from a short-term outlook to a long-term one by convincing our short-term elected representatives of the necessity of changing these priorities.

In the past few years many new innovative processes have evolved in the handling and disposal of solid waste. The following section is an attempt to present solid waste disposal methods practiced now or in the very near future, ranging from the primitive open dump to total recovery systems. Some of the newer processes have pilot plants in operation while others are still in the model stage, waiting for either funding or better technical methods.

DUMPS

Dumps have been in existence as long as mankind. In earlier centuries, if generated waste became a problem or hazard, inhabitants moved. Needless to say, that's not quite feasible today. Problems associated with them are numerous and yet, it wasn't till a few years ago that open dumps were apparently banned. Dumps were usually chosen without any consideration given to the problems they would create or to rapid urban expansion. Often there can be open fires near them creating dense black smoke due to incomplete combustion. Since they aren't properly covered they provide nice breeding grounds for flies, mice, rats and disease. This writer can remember five or six years ago when people used the rats at the Ancaster Dump for target practice. Another problem is the leaching into the subsurface soil of various acidic materials which pollute nearby open streams or underground wells. In a local example, a research team representing CHOP, proved with irrefutable results that the Ottawa Street Dump had severely polluted the Red Hill Creek area through the leaching and open run-off of acidic materials and phosphates. The dump has also been the chosen place for the dumping of

liquid wastes such as crude oil. Supposedly, it will be phased out shortly but in a recent solid waste study of Wentworth County by Proctor and Redfern, a firm of consulting engineers, it was recommended that it be expanded until at least 1980.

Waste management legislation passed in Ontario doesn't allow this type of disposal method but it is still being used in some smaller areas.

SANITARY LANDFILL

Sanitary landfill is one step up from open dumping and although if conducted properly it can eliminate most problems posed by dumps, it still can only be viewed as an interim measure between a dump and a more sophisticated process. The American Society of Civil Engineers defines sanitary landfill as:

A method of disposing of refuse on land without creating nuisances or hazards to public society, by utilizing the principles of engineering to confine the refuse to the smallest practical area, to reduce it to the smallest practical volume, and to cover it with a layer of earth at the conclusion of each day's operation or at such more frequent intervals as may be necessary.

The Environmental Protection Agency of the U.S. describes the process as one with four basic operations. After an in-depth study of an area in which the geology, water tables, soils and urban sprawl are taken into account, solid wastes are deposited in a controlled manner on proposed portions of each site. Spread and compacted into thin layers, the solid waste is hopefully covered with a compacted layer of soil of approximately six inches; which is done daily.¹

Landfill sites are usually chosen in one of two different areas. One is known as a depression landfill, a site which has

a natural or man-made depression in the terrain, such as quarries or gravel pits. One of the sites where Metropolitan Toronto had planned to transport its municipal solid waste to was a quarry type operation near Acton in Esquesing Township but that failed to materialize. The other type of landfill makes use of flat land such as marginal lowlands or marsh areas.² Once a site is in operation and is being operated properly, drainage must also be taken into account and most engineers recommend a one to three percent slope for adequate drainage, which is level enough to prevent erosion of cover material. Other factors taken into account have to be permeability of cover material, depth of burial, moisture, content and putrescibility.

One problem of a sanitary landfill which has received considerable attention is the generation of certain gases due to the decomposition of organic material under anaerobic conditions which produces carbon dioxide, methane and various other gases. Carbon dioxide can combine with water to form carbonic acid, which dissolves iron from tin cans and leaches into water tables causing extreme hardness of water in some cases. Carbon dioxide is not a hazard when compared to the release of methane gas over a number of years. Methane can be very combustible when mixed with air and as a result, no permanent buildings should be constructed over landfill sites. Methane could enter sewers or basements and become explosive. The provincial government has taken this into account and Section 46, Part II of the Environmental Protection Act states that:

No use shall be made of land or land covered by water which has been used for the disposal of waste within a period of twenty-five years from the year in which such land ceased to be so used unless the approval of the Minister for the proposed use has been given. 3

In other words, it is best to plan beforehand what use will be made of the area after landfilling is completed. Special foundations and pipelines to vent gas can be introduced but it is much simpler and cheaper to make it into a park, golf course, ski hill etc. and take into account the uneven settlement that will occur.

Uneven settlement is less likely to occur if the density of the solid waste is greater, meaning a longer life for the landfill. Two innovative processes which make that density greater are the shredder or grinding process and the baled or compacted process. Of the two, shredding is much preferred. While improved compaction even with up-to-date super-compactor type tractors which can exert 270 pounds per square inch in a landfill, a large volume of area remains. Air space is taken up by incomplete crushing of cans and spaces between objects. The increased marketing of the rigid type plastic container also dictates a need for shredding. All these plus the settling which is created when the organic fraction decays have to be taken into account. If a shredder is used then, why not apply it to composting also. See Figure I.

The city of St. Catharines features a Tollemache shredder which pulverizes household garbage and instead of incinerating it as Hamilton does, directly landfills it. Another interesting feature is that the city has two sites, one for putrescibles such

as household garbage and other non-putrescibles for such materials as refuse, brush and building materials. Ultimate use for the site is a park. The city engineer, M.M. Turnbull, felt that "this method provides for greater density in sanitary landfill, and is the most economical method of disposal available to date for a city the size of St. Catharines." A most interesting feature is that the location of the landfill of over 200 tons of solid waste a day is located within the city boundaries, within 50 yards of housing, so it should improve the image of garbage. The city's engineers don't say the system is perfect. Much of the shredded material is so light that it can be blown by the wind very easily. This can bother those nearby households.

A shredding type of operation in Providence, Rhode Island by the Northwest Compost Company goes a step beyond this. Material is shredded and removed continuously also magnetically separated. Your final disposal then is of shredded non-magnetic material while the magnetic ferrous material is stockpiled and sold.⁴ The city of San Diego is also attempting to use a shredder for recycling purposes, including composting. See reclamation section.

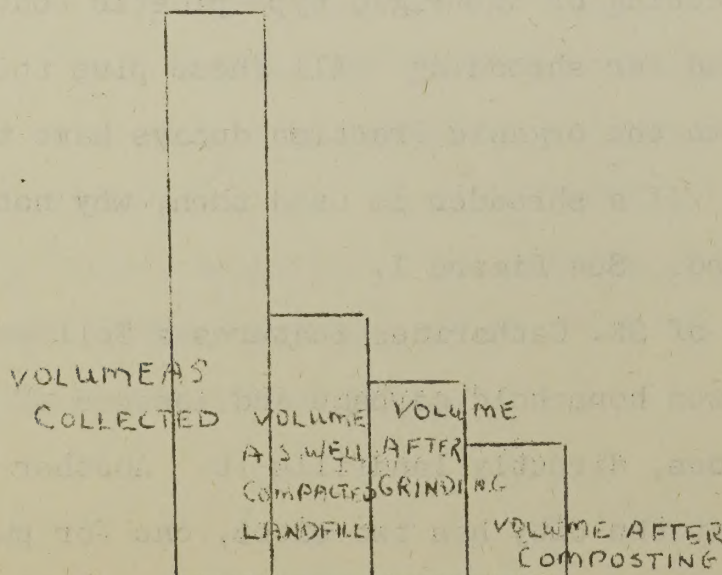


FIGURE I EXTENDING LIFE OF DISPOSAL AREAS

Compaction of solid waste has been used in the U.S. and Toronto has some ideas on doing it. Refuse can have its original volume reduced by 60-80%. This is a prerequisite for rail haul transport in order to cut down transportation costs. There are also projects where a compactor type of vehicle digs a trench for landfill and then dumps the material it has compacted into the trench. This type of operation is being carried out in Buffalo in Tonawanda, New York.

If open dumps have been banned, the most utilized method will be sanitary landfill, simply because it is the cheapest day-to-day operation on a short-term basis, but should be always look at disposal in this respect? Landfill can be anywhere from \$1-2 per ton. For a very stabilized high density landfill site a shredding operation is necessary which can be estimated at another \$2 per ton.⁵ Also you need high quality tractor compactors. Why not use composting at the same price which can also be an excellent solid conditioner. In the end it will be a question of how far urban areas will have to go to find enough cheap available landfill sites. There is only a certain number of miles you can go before transport costs make landfill unfeasible, not to mention the fact that there are no chances for recycling or reclamation of waste. One final question should be raised. A certain set of criteria have been set up to designate what a proper sanitary landfill site should be. The question is how many of these so called landfill sites fit into this category? In the U.S. it is found that 94% of existing land disposal operations were inadequate. What is the percentage in Ontario?⁶

COMPOST

For centuries compost has been used in agriculture as a soil conditioner. Traditionally, people relied on the law of return to maintain fertility of the land and up until the 20th century much of the biodegradable waste was returned to the land to replenish the soil. In Eurasia, for example, compost has historically been regarded as a way of upgrading domestic refuse into a soil conditioner. The poor soil provides a ready market for any compost produced. In small densely populated countries there was a need for soil conditioners which led to the development of processes using municipal wastes to create compost. In Amsterdam in 1929 a plant was built which converted 30% of the city's wastes to compost.¹ Composting is still widely practiced in Africa, Denmark, Central America, China, France, Columbia, Germany, Hungary, Japan, India, Switzerland, and Thailand.

Compost is still being used, but its uses are shifting from primarily a soil conditioner to a means of solid waste disposal as a way of sanitizing municipal waste. Artificial fertilizers have completely taken over the market in agriculture making the demand for compost almost non-existent in North America.* Farmers find artificial fertilizers easier and cheaper to use. Since W.W. II, 16 American cities have built composting plants to compost municipal wastes (see Table I). Only 6 of these are still operating. Most failed due to over optimistic views of the market available for selling compost, not because composting was an inefficient means of waste disposal. On the Isle of Jersey, a tourist center, it was de-

cided that composting would provide a solution to solid waste problems and could be used in local gardening as a soil conditioner. Composting is also used as a municipal disposal process in Edinburgh.

Compost is a humus-like material which is created by biological decomposition of biodegradable (organic) matter under certain conditions. The conditions for modern composting include aerobic decomposition under thermophilic conditions. Aerobic decomposition minimizes odour problems associated with composting and it speeds up the process. Thermophilic conditions (150-170° F) kill weed seeds and pathogens. There are assorted methods of composting but all include partial sorting to separate compostable materials from non-biodegradable materials, complete mixing of this matter and control of aeration, moisture content (40-70% water by weight) and temperature.

Compost is not a fertilizer because it does not contain enough of the major fertilizer nutrients--phosphorous, nitrogen and potassium. Compost contains 1% or less of each. It is a soil conditioner, which is an essential element in any productive soil, "A resource without which it will not be possible in the future to keep the productivity of the soil we need."²

The major types of solid waste that can be composted are municipal trash, agricultural wastes, food processing waste and sewage sludge. About 20% of municipal waste is putrescibles. In Canada there are 2 million tons of food wastes per year.³ Combined composting of municipal waste and sewage sludge has been suggested as a means of lowering cost for disposal and

also as a means of producing a product higher in nitrogen, phosphorous and potassium.

Reduction of particle size and homogenization of material is a necessary step for rapid degradation of waste and therefore part of all methods of composting. Most composting operations therefore contain some kind of mechanical mixer or shredder--rotating rolls, hammer mills, rasps or tumbling mills. The prepared waste is then composted by one of the following methods: low-cost biostabilization, windrows, or mechanical processes.

LOW-COST BIOSTABILIZATION. This method uses open farm land as a means of processing organic waste by loading the land to its limit without disrupting the decay cycle, or by using the land for compost and crop growth on a seasonal basis.

WINDROWS. Organic matter is piled into heaps about 6'x 10' and turned periodically to aerate the mass. This method is done in either a closed or open area. If the waste is pulverized first the process takes 6-12 weeks to complete a crude compost.

MECHANICAL COMPOSTERS. Many units have been developed to simulate the windrows process. All try to provide optimum conditions for the decomposition by control of temperature and aeration. All these processes were developed to produce a compost in a shorter amount of time than the windrows method.

METRO. The waste material is dumped into long uncovered tanks which are filled in layers. The material is turned by rail mounted buckets. Air under pressure is blown through the mass to maintain oxygen and temperature

conditions. The process takes 6 days to complete. The plant costs \$1.75 million to build and processes 300 tons/day, 6 days/week. The cost to the city is \$4.51/ton.

There is a plant in Houston, Texas which composts both municipal refuse and dewatered sewage sludge.*

NATURIZER. This process has steel apron conveyors 9'x200' move the material through cells. The material is agitated and mixed at the discharge point of each conveyor. No additional air is used and the temperature is controlled.

After digestion, the matter matures for 2 weeks. A plant in San Fernando closed after a short operating period.

The plant in St. Petersburg, Fla., processes about 100 tons/day, 6 days/week. The plant cost \$1.50 million to build and costs \$3.24/ton for the city to use.

FAIRFIELD-HARDY. This is the only composting plant in the U.S. in continuous operation for more than 5 years which is still operating. It contains round tanks 37'x 10' fitted with rotating bridges which agitate the material and moves it over a 3-5 day period toward a central discharge point.

Crude compost is screened to extract plastic material.

It is now possible to mix compost with fertilizer to increase nitrogen content and to pelletize.

SNELL. This is a combination of Metro and Fairfield-Hardy processes and involves a large open rectangular concrete tank. After sorting and grinding the refuse is combined with sewage sludge and conveyed to the digester.

Oxygen is supplied by pulling air down through the mass

* This plant is especially interesting because metals are separated magnetically for recycling.

with exhaust fans and is agitated by rotating angers. The plant processes 300 tons/day, 5 days/week and costs \$1.6 million to build.

DANO. This process is most popular in Europe. There are 52 plants treating 200 tons/day utilizing slowly rotating drums 10' x 76' equipped with air and water valves. Final maturation of compost takes place in windrows.

The material produced by most of these digesters or windrows is only a crude compost. Many of the original constituents of the garbage are still recognizable. If the crude compost is used in sanitary landfill operations no secondary treatment is necessary. If it is used in agriculture or gardening, further processing is required.

When the converting of municipal wastes to compost is mentioned, often compost is thought of only as being sold and used for agricultural purposes. This is quite true and is certainly a source of revenue if the market is available but we feel that it is most important to note that this need not be its only use. Composting above all is a method of waste disposal which allows one to handle large amounts of waste inoffensively. It sanitizes waste converting it into a dark, clean humus. It neither smells or looks like garbage. When considering the characteristics of compost we must remember that it is not a magical material capable of endowing great growing powers. It is not a fertilizer but is a very good natural soil conditioner. Once in this humus form, it can be used for many things. It can be sold to farmers, used by a city for enriching parklands, used for revegetation of ugly mining areas and mine tailings, or

as landfill for land reclamation and erosion control.

TO THE FARMER OR GARDENER: Compost as a soil conditioner has many values.

Compost serves as a storehouse of plant nutrients and by providing aeration and a binding effect on soil particles, it improves soil structure. Moreover, compost increases water holding and heat absorbing capacity of soils, and increases the buffering properties of the soil preventing rapid changes in acidity or alkalinity. In addition, compost has certain chemical effects upon the soil constituents, rendering various elements such as phosphorous more soluble and neutralizing substances which tend to be toxic to plants. It has a high base holding power and enhances the utilization of mineral fertilizers by plants. Finally, the material provides a favorable medium for the development of root systems and for the growth of common bacteria and fungi, and has an antagonistic effect upon micro-organisms injurious to plants. 4

When questioned, one agricultural scientist told us that to his knowledge composting was definitely not used to any significant extent in Canada - certainly not on a large scale farming operation. He felt that it was probably more confined to the backyard gardener. However, he said that the information, as stated above, was very valid and of great value.

As far as a market for compost is concerned, compost must compete on an economic basis, and convenience of handling and ease of applying basis with the readily available commercial fertilizers. Perhaps in future years as our sources of commercial fertilizers dwindle economic pressures may shift to the point that composting will become a valuable resource. 5

Talking of the dwindling supply of commercial fertilizers may seem far fetched but, in speaking with a professor in Environmental Biology at the University of Guelph, it became much more of a reality to us. Professor Robinson explained that commercial fertilizers primarily contain nitrogen and phosphorous. Phosphorous which is mined, is used in fertilizers, is absorbed and

utilized by the crops with wonderful effects...but when we simply throw away organic wastes (food wastes, leaves, grass, etc.) we are throwing away this very finite resource of phosphorous as well. Most of the phosphorous in the discarded organic matter, ultimately ends up in the earth's sink, the oceans. In such a dispersed state it cannot, of course, be remined and recovered. If however organic materials were composted, the phosphorous would be able to be returned to the land in a state available to plant life.

The second substance, nitrogen, is in danger in another way. In order for plants to be able to utilize nitrogen, it must be "fixed". This process of fixing nitrogen takes place naturally and probably always will. However, in order to put "fixed" nitrogen into fertilizers, it has to be done by an artificial process requiring a great deal of energy. North America has for the first time this past year felt the warning pangs of what could be a future energy crisis. What does this mean for the commercial fertilizer industry? Perhaps in the not too distant future, it will find itself unable to acquire the large amount of required energy, or at least not as much as at present. Again, it is significant that nitrogen found in compost is fixed naturally in the fields with no extra expenditure of energy.

Another aspect which ought to be mentioned is the concern for dangers resulting from the excessive use of concentrated artificial fertilizers. Robert Rodale in Compost Science stated that many American water supplies were found to build up toxic quantities of nitrates under widespread use of artificial fertilizers.

After an application of chemical fertilizer almost every living element in the soil gets jazzed up beyond its normal rhythm of life for a short time. In that frantic period the humus stores of the soil are depleted, because humus is the one thing that helps balance out the insult to the soil from outside chemicals. As a result soil structure and texture is degraded, causing rain to have difficulty entering the soil...The proper balance of all food elements is lost, because no man can figure out how much of each soluble nutrients plants will need in any given season. 6

Compost as a natural source of humus could perhaps be used in conjunction with fertilizers and in this way ensure the continued revitalization of the soil.

As a source of chemical plant food, a compost mixture can be adjusted to a certain extent to contain more or less amounts of nitrogen. An example of this would be mixing municipal solid waste with municipal sewage sludge or animal manure, both of which are very high in nitrogen. This type of combination, as well as yielding an enriched compost could ease somewhat the sewage sludge and animal feedlot disposal problems. Compost is highly valued in many parts of the world, and perhaps it should become more so here in Canada

OTHER USES FOR COMPOST: 1) EXTENDING LIFE OF DISPOSAL AREAS

Many landfill areas are having problems of late because of fast decreasing space. In other cases cities which have decided to try composting as a waste disposal method are having great difficulties finding markets for their compost product. It has been suggested by various people that composting be used as a complimentary process to sanitary landfill. As this concept is investigated more closely it can be seen that this combination would in fact solve many of the other problems associated with sanitary landfill. Even with the compacting wastes before being

landfilled voids exist due to incomplete crushing and eventual organic decay. Several studies on landfill have shown that grinding would eliminate many of these voids and extend the life of a landfill site. A prerequisite of composting is grinding. If composting were a prerequisite of sanitary landfill, most of the organic decay would already have taken place, and under much more sanitary conditions. This would mean less volume to be landfilled and much less future settling of the landfill site.

Another problem appears when refuse disposal takes place on a regional scale. Sewage sludge and industrial wastes are often added to the volume of wastes to be landfilled. Both of these types of wastes have high organic contents and therefore could be dealt with very efficiently through composting (volume reduction and stabilization).

Sanitary landfill of raw refuse requires an elaborate handling process. The need to compact waste into cells and cover them with a suitable soil would be eliminated if compost were landfilled. Compost is already sanitized and therefore needs no special handling.

Some have stressed that compost is too expensive a substance to landfill, but need it be? An article in Compost Science says that a less refined type of compost which would not be suitable for agricultural purposes would be fine for sanitary landfill and less expensive to produce. This article also suggests that if reclamation and selling of salvage were incorporated, there would be considerable savings in long term land and cost requirements.⁷

Whereas some sanitary landfill sites have been plagued with methane gas problems, landfill or compost would be free of this. The decomposition which causes such gas production has already taken place. In addition to this the landfilled compost site would be much less apt to pollute underground water and much more apt to be structurally competent so that the land could be used for many more things soon after its life as landfill site is complete.

In conclusion, it seems that at this time although there is only a little hope of establishing a market for compost, "composting" of municipal waste should not be forgotten. It is in the opinion of our research staff much better and more rational an approach to the problem of solid waste management than that of sanitary landfill.

Compost is a surprisingly useful substance, and has many uses. Cities can enrich their green belts and parks at no extra cost with compost. Areas which suffer from soil erosion due to lack of humus can also benefit greatly from compost application. Experiments are being done converting municipal waste into a type of compost used specifically for growing mushrooms. Although this is only a limited application of compost, it does allow one to see that there are certainly many and varied uses for compost made from municipal waste.

2) REVEGETATION OF MINING SITES AND TAILINGS

Today we are much concerned about the quality of our environment. There are (in the U.S.A.) 800,000 acres of abandoned strip mine lands, scattered all over our country, spoiling many areas. Reclaiming this land would never pay in profits, but in the name of beautification we can and probably will subsidize such reclamation. Many of these despoiled lands are unproductive

because they do not have organic materials in the surface. Compost certainly would be one reasonable method of applying organic material to the top soil. And the compost would not have to be high grade material used in luxury agriculture. Glass shards, can shreds, and the like would be no worse than the rocks in the mine spoil. The need is to get the land back to where a plant cover can begin to grow. 8

Canada has much the same problem in one of her areas.

CANADIAN COMPOSTING RESEARCH:

Here in Canada even less research has been done on composting than in the United States. There has been, however, one proposal submitted to the Ontario Government by two Queen's University professors, Drs. R.H. Clark and J.H. Brown, for a prototype Reclamation Plant in the City of Kingston. This plant would be capable of recovering the most valuable components of municipal waste. The most important salvage prospects are seen as metals and glass.

Salvage will be accomplished with handpicking except for the ferrous components which will be removed magnetically. A Fairfield-Hardy compost system has been designated for reduction of the residual mass. The authors of the report acknowledge the lack of available market for the compost, but consider the process simply as a means of sanitizing organic wastes. 9

The Kingston plant will be similar in concept to that operated by Metropolitan Waste Conversion Corporation in Houston, Texas, U.S.A. Instead of trying to sell the final compost, Kingston proposed to dispose of it as sanitary landfill.

Composting has higher initial capital costs than pulverization and landfill, but the leachate problems are minimized and the deep crude compost promotes the rapid growth of vegetation. In addition, the problem of supply and storage of cover is solved. 10

Composting as a "biostabilization" process of all organic wastes ought to be investigated as a potential waste disposal method especially for small communities. The expected operating costs for a 100 ton/day capacity plant are \$9.80/ton of refuse but these would fall to about \$5.60/ton for a 400 ton/day unit. The projected capital costs would be \$925,000 -- \$2,003,000.

Other than the Clark and Brown proposal, most of the Canadian Research on composting appears to be taking place at the University of Guelph in Ontario. There they have the facilities and knowledge of biologists, agricultural scientists, engineers, and microbiologists. Through our contact with one of the professors we discovered that they have and are using a mechanical composter of their own design. It is just a model and therefore very small in scale but it is allowing them to carry out some very interesting research.

From November 1971 to March 1972 this unit was used to investigate the compostability of municipal refuse from the city of Guelph and poultry manure.

The composting facility, consisted of a high rate composter housed under the same roof as ancillary equipment for the sorting, combination, and blending of municipal refuse with broiler chicken manure. Diagrammatically the complete process from incoming refuse to finished compost is shown in Figure I 11

Before beginning the compost process, any salvage such as glass, metals, rags, and plastics were handpicked from the waste and kept to be sold if possible. The remainder of the refuse after being ground went through the 3 day composting process. During this time it was mechanically turned and aerated. The 3-day compost was stockpiled and allowed to mature. At present, the

mature compost is being evaluated as an aid to the restoration of vegetative cover on a former gravel pit site. Some of the mature compost has also been reground and screened and is being tested by the horticultural industry. The researchers, Prof. Bell and Pos calculated the costs as follows:

Small scale: (this size)

- a) with sorting and no salvage income - \$22.66/ton of compost
- b) without sorting or with required sorting by householder - \$12.25/ton of compost

Commercial scale:

- a) no sorting - \$5.00/ton of compost

Presently the compost unit is being used to test the compostability of sludge from paper mills. Normally this sludge has to be landfilled after being removed from settling tanks. The university has also inquired into the compostability of wood chips and sawdust in conjunction with sawmills in Northern Ontario. Up until this time "tipi burners" have been used to dispose of these organic wastes. However, the burning is very incomplete resulting in considerable air pollution.

It is encouraging to see both the quantity and quality of the research being done at the University of Guelph...so little seems to be done elsewhere in Canada. The compostability of municipal waste has been proven in several cases both in the U.S.A. and at Guelph. Professor Robinson of the University of Guelph stated that composting as a method of waste management would only be successfully when people were ready to accept it fully. He admitted that a lot of reeducating needed to be done before this could happen. Another primary obstacle to composting as he saw it was the development of a composting unit that would be relatively cheap to initially build and later to operate.

SUMMARY:

The discussion of composting has very often concluded with only a list of its disadvantages. We would like to briefly discuss some of these alleged "disadvantages" in the following and then end this section by mentioning some of the advantages of composting.

Often the fact of limited markets (due to the wide use of and low costs of chemical fertilizers) for compost has been cited as a problem. To this we say that composting need not be sold only for farming. It can also be used on city parkland or in land reclamation as mentioned earlier. It is also wise to keep in mind that chemical fertilizers may not always be as plentiful as they are now.

High operating and distribution costs are another reason used against composting, yet cities do not now require that sanitary landfill or incineration "break even". Composting at present stands on a par with incineration cost-wise.

Many municipalities are reluctant to venture into a commercial setup of waste disposal, especially when so many of the composting operations in the U.S.A. have "failed" in the commercial sense. Perhaps a more dependable base than revenue should be used for composting. Professor Robinson of the University of Guelph for instance feels very strongly that it is unwise to decide on composting as a waste disposal method because of the money which will be made from the sale of compost. He says that a city should not expect to sell compost...but he also says that there are a great many other reasons to justify the use of composting.

He agrees that many fail to recognize composting as a method of solid waste disposal. One section in the report from Guelph reads:

Economics aside, composting can only be a reasonable reposition if the end product is of more value and less objectionable than the raw materials. The usefulness of composts as soil conditioning agents is well documented and there is certainly no argument over the improved aesthetic properties of compost over either refuse or poultry manure. 12

Much more public education is needed in this area to help people become more aware of the true characteristics and capabilities of compost.

Another excuse waged against composting is that of the variable quality of the compost produced (contains metal, glass, and plastic pieces). Again perhaps more composting operations should use the bulk of compost for landfill or mine scar revegetation, etc. For these above mentioned uses a low quality compost is quite suitable. The demand for agricultural compost could dictate the amount of low quality compost which is refined or upgraded for agriculture.

On the more positive side of composting, it is a process which is able to convert municipal waste into a highly usable end product. The Guelph report also states:

The present study has demonstrated the technical feasibility of producing a good quality compost from broiler manure and municipal refuse. Municipal refuse based composts will become a commodity of agricultural importance in the future of North America just as they are now in Europe. It is doubtful if compost will ever totally replace commercial organic fertilizers. However, the quantities of the latter used in the future may be markedly reduced by the complimentary use of carefully selected composts. 13

A composting plant can be situated right in or very near to a city and this decreases haulage costs tremendously (very vital with increasing amounts of waste). The composting plant in Houston, Texas for example is only ten miles from the downtown area. The salvaging

of materials such as metals and glass could also be incorporated right into the plant designed also if desired. If this were the case, some revenue could be expected from the plant.

If one considers the future with the possibility of regional waste disposal schemes, composting becomes a very attractive prospect. In these regional setups, municipal waste, sewage sludge and industrial waste will probably all be disposed of together. Composting is capable of handling this type of mixture without any difficulty. Such a mixture can in fact enhance the quality of the compost produced.

In conclusion, we share the ideas of the following quotation from the article, "Composting - A Third Choice" in Compost Science.

Wastes management via composting is a distinct possibility for the 1980's. The composting method and product will be different from the present. It will not be composting to make a valuable commodity out of waste; rather, it will be using biological phenomena to stabilize and minimize the volume of solid waste that must be incorporated back into the land. It will be a true third choice of processing wastes so that discharge to the environment can occur without environmental quality degradation. 14

INCINERATION

Incineration is not a relatively new process. Engineers have been developing larger and more sophisticated incineration equipment since the late 1800's. The essence of the incineration process is combustion in which the hydrocarbon compounds of refuse combine with oxygen, either forced or free-flowing, to form carbon dioxide and water.¹ This leaves the minerals and metals as solid residue. Oxidation will release heat energy to sterilize the residue, destroy the odorous compounds and convert the water into vapour which, together with carbon dioxide joins the atmosphere in

an acceptable state. This is the ideal situation but there are many variables which have to be taken into account. These include the types of materials being burned at a certain temperature for a certain period of time. If all these are not taken into account, you may wind up with the same effluent as open burning and that is dense black smoke.

The use of incineration for disposal of solid waste follows closely the rapid growth of cities and it does have certain advantages over dumping and landfill. As cities grew and land became more expensive, it was necessary to think of different methods of disposal. Incineration requires much less land and can be built in a central location in order to keep the high cost of transporting the refuse down. In an area where a seasonable climate is a factor, an incinerator's operation is not affected to any large extent. Also an incinerator can handle varying amounts of waste but cannot be expected to handle large uncompacted materials or those that are explosive. However, incinerating waste just for the sake of disposing of it, with no energy being harnessed or any reclamation being done seems a little ludicrous in this day and age.

With incineration, you also need some type of landfill site because incineration is not a complete disposal method. Approximately 20% may wind up as being landfill. Residues such as sterilized ash, slag, metals and glass must be disposed of elsewhere. Why not try and separate these non-combustible materials such as metal and glass beforehand? The can and steel companies, in order to keep their beverage containers on the market, are now supposedly willing to buy back all magnetic waste found in Municipal

waste in Ontario but they can't after incineration. The glass companies say they need all the cullet they can get. There are techniques available to sort glass also.

These processes have only evolved recently but have not received that much attention because they can be added expense to an already large capital investment. Incineration when compared with landfill is a somewhat higher initial expense but that drops over a long-term period as transportation to a landfill site rises. However with an incinerator there are also high maintenance costs, especially with the older models, and higher labour costs for skilled operators. The relatively higher temperatures created by the introduction of plastics has caused some cracking of refractory linings.² Again, it's a problem that as the refuse is being incinerated becomes more complex, the equipment to handle and dispose of it must also become that much more complex. Incinerators of thirty years ago just cannot properly handle the waste unless expensive renovations are made to them. At present, five of Toronto's six incinerators are antiquated to some extent, unable to meet pollution abatement standards set by the province in the 1970's. Of course this isn't as much a problem in Canada as in the U.S. as there are approximately twenty municipal incinerators here.

With incineration there also has to be allowances made for the higher air quality standards. Incinerators now have to be built with expensive electrostatic precipitators for released carbon particles and scrubbers for released gases. Of course, industry has to use them for their refining operation. Lake Ontario Steel in Whitby, which won a provincial award for pollution abatement has

precipitators which gather approximately 8 tons of particulate matter a day.³ Imagine what Stelco and Dofasco's precipitators gather when they're in service! Potential corrosion is another problem that has to be taken into account. One already mentioned is the high temperature produced corrosion aggravated by high gas temperatures. There are also possibilities of nonuniform furnace temperatures corrosion, low temperature or dew-point corrosion and also HCl corrosion.⁴ (See plastics section).

An innovative method in incineration is a process known as "total incineration" which makes use of supplementary energy to create a blast furnace type of incineration with maximum volume reduction of waste and elimination of large residue disposal operation.⁵ Temperatures reach approximately 3000 F in this operation and you're left with a material which is almost volcanic in appearance and nature. Hamilton's SWARU burns at 2500 F.⁶ There are many processes available but with the cost of energy increasing rapidly, the cost of the process is relatively high.

INCINERATION WITH HEAT RECOVERY

Until recently, incinerators in North America have been designed with little regard given to installation of waste heat utilization facilities as is done in Europe. There, the aim is to completely burn out the refuse for heat utilization. North America has had so much natural fuel resources available, such as coal and natural gas, that little attention was paid to European processes, necessary there because of the high transportation cost of fuels. European methods have also been found to cut down the operation costs significantly. For example, in Berne, Switzerland, the municipal incinerator supplies heat in the form of steam for two factories,

a hospital, a dental school and a public school. The operating costs are 6,500,000 Swiss francs and the income from the sale of the steam is 560,000 Swiss francs.¹ This represents a long-term investment from which it is possible to profit. However, there is no sense in building an incinerator for heat utilization unless you have a market for the steam. Mention should also be made of the high cost of both waterwall construction and refractory lined types, although waterwall types have more advantages, such as better heat transfer efficiency causing less possibility of air pollution.²

In Canada, Hamilton and Montreal recently built incineration processes capable of utilizing heat recovery. It is interesting to note both incinerators are incapable of handling the amount of waste produced with the rest being landfilled. Another interesting feature is that neither have found a market for the excess steam produced.

SWARU (Solid Waste Reduction Unit)

The reason that Hamilton started looking for newer methods of disposal was that no suitable landfill sites could be found near the city. All existing landfill sites were projected to be filled by 1975. Gordon L. Sutin and Associates came forth with a projected plant for Hamilton which cost approximately \$8½ million to handle 600 tons of refuse a day. At a cost of another \$4½ million it could be expanded to handle double its capacity. However, it is only operating at approximately 300 tons, 12-16 hours a day. Mr. Sutin claims that SWARU can be operated cheaper than a landfill site. He estimated the disposal costs could be \$7.06 per ton including amortization of plant and equipment if the plant handles

200,000 tons per year. This doesn't include any revenue made from heat recovery or reclamation of ferrous metals. At present, these amount to very little. Approximately \$ $\frac{1}{4}$ million per year could be realized if the plant was in operation at full capacity and generating enough steam to sell. The ideal location for this operation would be near the heart of a city. He felt that the metal recovery system set up by M&T Products was strictly a promotional gimmick on the part of the can industry and no industry would buy the excess steam produced. There is also a problem that the pulverizers installed might be too small to perform their job adequately. Also wire falling down is causing jamming problems. The incinerator only accepts municipal waste at the moment with contractors hauling private waste to sites such as the Ottawa Street Dump. SWARU may have many problems but at least it is parting in the right direction as far as recovering some useful products from incineration.

Another example of this type is the Chicago Northwest incinerator. It is the newest and most modern of the large capacity type of incinerator. It is designed to support four 400 tons per day furnaces (1600 tons per day) all having waterwall type construction. This represents an enormous capital expenditure but seems to be a viable method of increasing revenue.

At present, only 15-20% of existing North American municipal incinerators have heat utilization facilities and of these only 2% of the total number produce enough to sell to outside purchasers. As you can see, as of yet there is little being done in the type of operation although much more can be expected in the future, if incineration is regarded as the best disposal method.

Mention should also be made that many of the smaller type incineration facilities are being shut down as air quality standards rise. However, most large hospitals have their own incineration facilities. Ecology Industries System claims to have solved the problems generated by them. They have introduced a well-adapted system for large hospitals which grinds, to reduce volume by as much as 80% and then incinerates to produce heat. Non-combustibles and ashes at the bottom of the combustion chamber are carried to an outside conveyor. One such system is supposed to be in operation in a Chicago hospital this year.⁵

As solid waste continues to grow and land price continues to rise in urban areas, incineration is bound to be used to a greater extent. Studies have shown that 5 to 15 acre-feet per year are required per 10,000 population for disposal of solid waste, excluding industrial types. This can represent approximately 250 acre-feet per year on a landfill site for a city of Hamilton's size. Quite a sizable portion of land. An incineration process can cut down the amount of land but the high initial cost and the fact that you also need some sort of landfill site for non-combustible residue have to be taken into account. As a reclamation system, paper, one of the most valuable elements of refuse is destroyed and reclamation of other materials is more difficult or impossible to achieve. Steam can be produced as an offshoot of newer models but markets have to be found for the excess steam. So far, large-scale waste heat utilization seems unpractical in most areas because the operation has to be a continuous 24 hours a day venture. Perhaps instead of incineration, we should look back to composting with sanitary landfill or forward to such processes as pyrolysis.

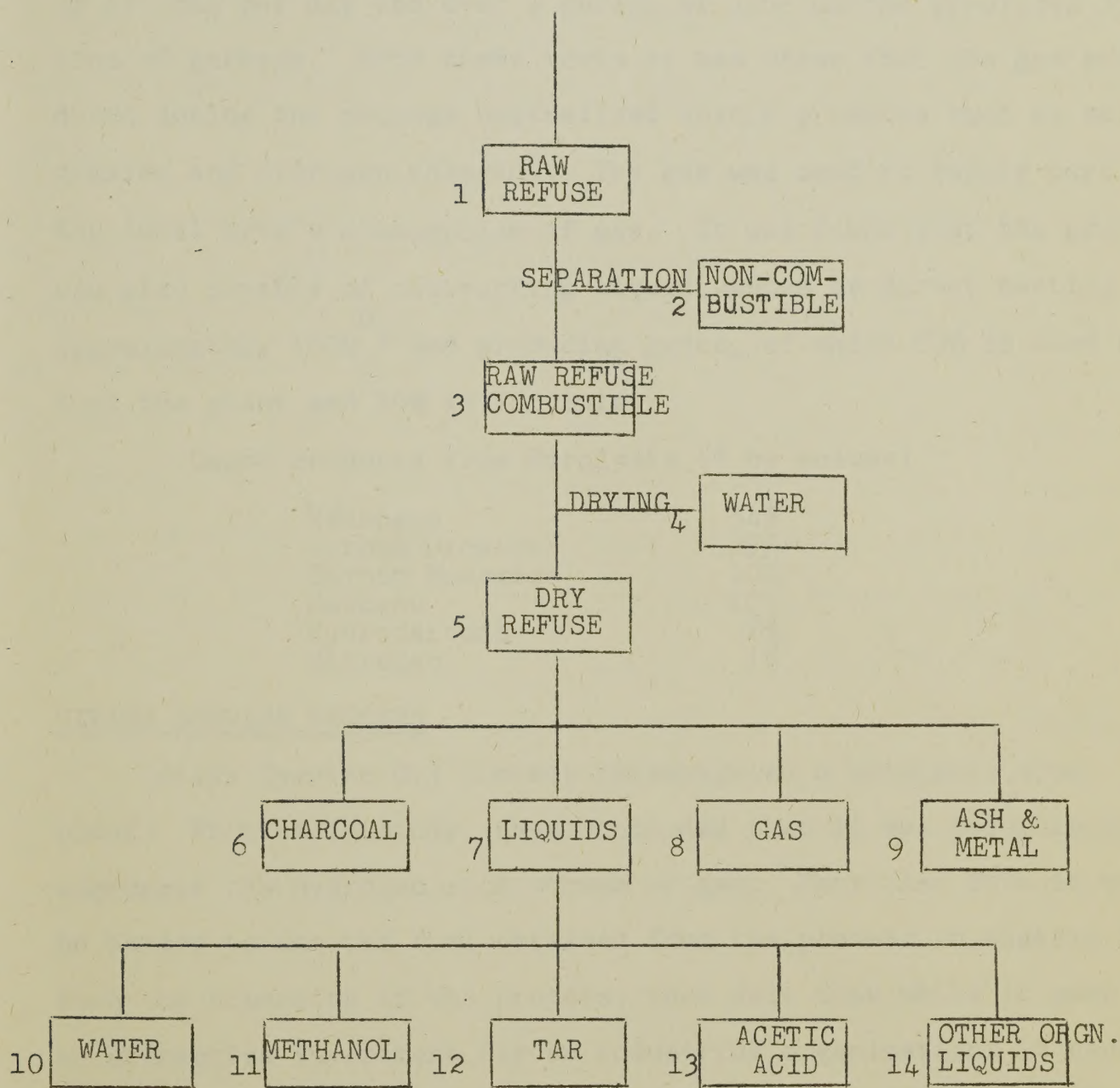
PYROLYSIS

Pyrolysis is defined as "the chemical change brought about by the action of heat". Often described as destructive distillation, it is basically a process of reforming or gasifying the decomposable portions of waste by controlled heat in the absence of oxygen.¹

Pyrolysis is not a new process. It has been in use for many years to produce methanol, acetic acid and turpentine from wood plus recovery of the residue that is left or what is known to us as charcoal. However, it has only been recently shown that pyrolysis is a technically feasible method of municipal refuse disposal which can produce useful products with little environmental pollution. Rather than being buried or incinerated the organic portion of a number of solid waste materials is reformed into lower molecular weight compounds which could have some significant economic value.²

From the pyrolytic process, four broad classification of products are obtained. Tars are a small portion of the total products formed and decrease with increasing temperatures. An aqueous mixture is formed largely made of water and water soluble organics. There is also an organic fraction which contains a complex mixture of various materials including dissolved gases. A final product is a mixture of gases which are not condensed at dry-ice acetone both temperatures.³ Of the products formed, the organic liquid portion is most important because it is the potential source of synthetic crude oil. There are various pilot plants already in operation and each uses a form of pyrolysis.

GENERAL FLOW SHEET FOR REFUSE PYROLYSIS



MATERIAL FLOW OF REFUSE PYROLYSIS

DESTRUGAS PROCESS

This is probably the most sophisticated and technically advanced plant to date in Europe. The plant was built with a capacity of 18 tons per day and over a period of nine months pyrolyzed 3000 tons of garbage. From these tests it was shown that the gas produced during the process neutralized acidic products such as sulphur dioxide and hydrogen chloride. The gas was used to supply part of the local area's consumption of gas. It was found that the process was also capable of destructing liquid wastes by direct heating at approximately 1600 F and producing gases, of which 80% is used to fuel the plant and 20% is for sale.

Gases Produced from Pyrolysis (% by volume)

Hydrogen	54%
Carbon Dioxide	23%
Carbon Monoxide	10%
Methane	10%
Hydrocarbons	2%
Nitrogen	1%

CITIES SERVICE PROCESS

Cities Service Oil Company investigated a pyrolytic type plant. From their study, they concluded that it was possible to segregate the hydrogen rich stream of gas. They also felt it would be better to use the fuel obtained from the process to sustain it. With the economics of the process, they felt that while it wasn't an attractive investment for an industrial organization, it could be for a municipal one. They feel disposal costs could be lowered to \$1.25/ton.

MONSANTO LANGARD PROCESS

This process claims to handle all types of municipal wastes, economically and in a non-polluting manner. It can also reconvert the waste into energy or various products. The variation of the

Langard system is that it operates in an oxygen-deficient rather than oxygen-free atmosphere. The process is a complete one, including receiving and handling of solid waste, shredding, pyrolyzing, gas purifying and residue processing. Gases produced are drawn into a gas purifier and burned cleanly at temperatures high enough to destroy harmful gases and odor.

UNION CARBIDE PROCESS

Dr. James Potts of Union Carbide has done much work in the plastics field. Recently he experimented with pyrolytic methods to convert waste plastics into a wax, a grease or a liquid at will. It can also be converted to a gas for use as a fuel or raw material. Possible sources of waste plastics are in-plant scrap from fabricators and the waste plastics which can perhaps someday be separated from domestic waste. As present Union Carbide's unit can handle 100 pounds per hour.

Costs

From an economic viewpoint, all systems vary with each facility. Capital and operating costs are about 2/3 of those associated with non-polluting incineration. For example, let's look at a cost analysis:

Operating Costs of 5000 Tons/Day Pyrolysis Plant

<u>FIXED COSTS</u>	<u>\$ MILLION</u>	
Labour	0.49	
Supervision	0.15	
Overhead	0.64	
Maintenance on site	1.00	
Maintenance off site	0.24	
Taxes and Insurance	0.49	
Total Fixed Costs	3.01	\$1.65/ton

VARIABLE COSTS

Water and Power	0.20	
Fuel	<u>0.70</u>	
Total Variable Costs	0.90	\$0.49/ton
Total Operating Costs		\$2.14/ton

Total Investment for 5,000 Ton/Day Pyrolysis Plant

INVESTMENT\$ Million

Inside battery limits	16.0
Off site	<u>6.4</u>
Total	22.4

ADDITIONAL COSTS

Contingency	5.6
Construction Interest First Year(8%x33%)	0.7
Construction Interest Second Year(8%x67%)	1.5
Startup extraordinary(8%x100%)	<u>2.41</u>
Total Investment (includes working capital)	32.6

This has to be on a regional basis. It cost Hamilton \$8½ million to dispose of 600 tons of garbage by incineration. The reaction in pyrolysis takes place in a closed system, minimizing air pollution problems and does not require expensive control equipment. Pyrolysis units can be operated at somewhat lower temperatures making them cheaper to build and less critical to operate. They can be built to large capacities whereas incineration units seem limited to 1000 tons per day, making large pyrolysis units cheaper.

From a three year study of pyrolytic methods in San Diego, it was shown that (1) the volume reduction is in excess of 50% (2) once started the process is likely to be self-sustaining (3) the inert solids are satisfactory landfill material (4) the other

products yielded by the process may constitute materials for a salvage market (5) the capital cost of large-scale equipment is about 67% that of incineration. Although incineration can create 10-20% more volume reduction, pyrolysis has to be looked at as a viable alternative in regional disposal plans, if markets are found for secondary products.⁵

Pyrolysis as a process is ecologically less regressive with respect to ultimate conservation of resources because potentially useful products are created rather than carbon dioxide in large amounts.

PYROLYSIS - COMBUSTION METHODS

It was thought that perhaps this method should be noted although it really hasn't been tested with municipal waste yet. The following table shows that figures here are very preliminary in nature. It is interesting to note here that operating costs, based on a 24-hour continuous operation including grinding fuel material could be on the order of \$5.05 per ton.

PRELIMINARY ECONOMIC ESTIMATE FOR PYROLYSIS-COMBUSTION SYSTEM OF DISPOSAL OF SOLID WASTES FOR A 200-TON/DAY SOLID WASTES CAPACITY (OVEN DRY BASIS)

A. PLANT COSTS	INSTALLED COST (\$)
Two Carbon-Steel Reactors(3 ft. diam x 30 ft. high)	10,000
Two Furnaces for Above(complete with instrumentation)	400,000
One Stationary Cylindrical Furnace (6 ft. diam x 30 ft. high; complete with instrumentation)	400,000
One Multicyclone System	20,000
One Waste-Heat Boiler(56,000 lb/hr capacity)	225,000
One Scrubber	14,000

Two Feed Systems for Stage 1 Reactors, plus Cyclone Separator, etc.	200,000
1. Total Equipment Costs	<u>1,269,000</u>
Piping (20 percent of total purchasing cost excluding furnaces \$469,000)	103,000
Instrumentation (15 percent of total purchasing cost excluding furnaces)	70,000
Control Room	<u>25,000</u>
2. Cost of Physical Plant	<u>1,467,000</u>
Engineering (7 percent of physical plant cost)	103,000
3. Direct Plant Cost	<u>1,570,000</u>
Contingency (15 percent of direct plant cost)	235,000
4. Total Plant Cost	<u>1,805,000</u>

B. ANNUAL DIRECT OPERATING COSTS ^a:

Eight Operators (\$10,000 each including fringe benefits)	80,000
Supervision	15,000
Maintenance (5 percent of physical plant cost)	73,400
Water and Electricity	15,000
Insurance and Miscellaneous	<u>30,000</u>
5. Total Annual Operating Costs	<u>213,400</u>
6. Direct Operating Cost/ton-day	3.05
Grinding Costs/ton-day (200 tons at \$2.00/ton)	2.00
Total Operating Cost/ton-day	<u>5.05</u>
Earnings from Generation of Steam/day b,c	1,010
Earnings from Generation of Steam/ton-day	5.00

- a Continuous 24-hr/day, 7 days/week, 350 days/year operation
b By-product steam value at \$0.75/1000 lb
c Heat value of solid wastes feed assumed to be 5000 BTU/lb ⁶

RECYCLING, RE-USE AND RECLAMATION

One word which has received tremendous publicity in the 1970's is recycling. Salvage dealers are no longer junk men but recyclers or solid waste handlers. Even politicians are taking it to heart. Hopefully it will stay that way. Each of the sections dealing with the components of solid waste go into a lengthy discussion on it. This section will look at the three R's through various

processes of recycling from home separation to operational types of sorting and segregating.

Perhaps it would be better if we defined the three terms first. Recycling takes the product and reintroduces it into the production cycle for the production of the same production. Re-use denotes use of a product more than once as is. Reclamation consists of processing for re-use as a different material. In relation to these terms, solid waste disposal no longer implies getting rid of a material but takes into account how that material can be part of a closed system where it is converted into a new cycle rather than being buried or burned. Many techniques are now becoming available to segregate waste for recycling but the easiest and most time-consuming way is home separation. The only effort we shall go into is the Burlington Pilot Study which is the largest being carried on in Canada.

BURLINGTON, ONTARIO

Over a five month period, from August, 1971 to June, 1972, the town of Burlington (pop. 85,000), in conjunction with the waste management branch of the Ontario Ministry of the Environment, administered a pilot project of "in house" separation of garbage. The aims of the project were to gather information on per capita waste, components of waste, public interest in household separation, costs and problems with running a collection and markets for the collected wastes. It was decided to run the project in an area covering 4,000 persons, 5% of the Burlington population. Newspaper, clear glass, colored glass, and metal would be separated. The pickup of the separated garbage was done at the same time as the

regular pickup. A truck divided into four wooden compartments with removable walls would be followed by the regular packer truck. This method of collection would clearly cause great expense on a large-scale basis due to more than double labour, transportation and separation costs. The regular garbage contractor provided the trucks for the pilot study with a driver and a loader at \$132.64/week.

This included no profit for the contractor. The newspaper was sold to Mill Fibre for \$8/ton, the glass to Dominion Glass for \$12/ton and the metal to M&T Products for \$10/ton. It was found that at present there is only a very limited market for all these waste materials in the Hamilton area. From the average figures of separated waste, the revenue obtained per week was:

Newspaper	1.867 ton	\$8.00	\$14.94
Metal Cans	.333 ton	10.00	3.33
Glass	1.014 ton	12.00	<u>12.17</u>
			30.44 per 1 week

This means a deficit of about \$100/week.

It seems clear that "in home" separation is rarely the most efficient means of collecting waste materials for recycling. We are not saying this is wrong though. In some situations, ie. Madison, Wisconsin, separation of one element of waste--paper--is both efficient and profitable, but in general separation should be done at a central municipal plant (eg. Black & Clawson).

Burlington CCPC still carries on the project with a civic-owned building being used on the Guelph Line as the depot centre. Needless to say there are some very dedicated people in Burlington who volunteer their time on weekends to keep this depot running.

Some of the objectives of solid waste management must be kept in mind in relation to the urban generated portion of solid wastes. You are trying to economically recover and adequately process for reclamation and recycling increasing portions of the solid waste streams by improving the efficiency of operation through increased mechanization and reduced labor requirements. Keeping this in mind we can look at mechanical type operations which are either working or will be in the near future. Machine sorting involves some kind of specialized sorting equipment either by density and drag, air or liquid flotation, pulping, conductivity, photometry, radiometry, etc.

SAN DIEGO

From a Solid Waste Disposal Study Group, the city of San Diego has developed a working model of a reclamation process they will attempt to put into use. The city is developing a mechanical sorting system for municipal refuse which will begin with a dumping pad on which refuse is stockpiled. The refuse is then taken from the pad to a shredder which shreds it into approximately 5 inch particles. From there gross separation begins. A cyclone collector draws off all the lightweight elements (paper, plastics, leaves, etc.) by utilizing a tower containing multiple vertical compartments each with rising air streams of different velocities. The heavier elements are separated by a magnet for ferrous metals, aluminum and glass by other processes. Grass cuttings, yard trimmings, etc., will be used for a composting process.

As you can see, the San Diego process doesn't use any innovative methods such as pyrolysis, but places reclamation first in their

priorities. The city feels that reclamation should be a long-term resources cycle of perhaps fifty years, which should include composting.

BLACK & CLAWSON HYDROSPOSAL AND FIBRECLAIM PULPING PROCESS

Black & Clawson, a multi-divisional world-wide service corporation of primarily pulp and paper equipment, decided in 1969 to enter the solid waste management field. Mention must be made before continuing that their pilot plant in Franklin, Ohio would not have been built without 2/3 funding from the U.S. Environmental Protection Agency, and the remaining 1/3 being contributed by the city of Franklin, Black & Clawson, and the Glass Container Manufacturers Institute. The heart of the Black & Clawson process is the hydrosposal which is similar to systems used in hundreds of paper mills. Refuse is fed into the hydropulper and there reduced to pulp. Since paper is usually close to 50% of domestic waste there is no problem. Later the system was expanded to include extraction of ferrous metals and extraction of glass. The glass separation is interesting because the Sortex optical separation discriminates between different shades such as clear, amber and green.³ (See diagram).

Also built next to the plant is a regional sewage waste treatment facility which complements the hydropulper. Sewage sludge is mixed with the residue solid waste pulp and jointly burned. The treated effluent from the sewage plant is used to supply the plant pulping process.

It must be remembered that the Franklin plant is only a demonstration plant and operating costs for it are high.

Net Operating Cost per Tone (including credits for metals,
glass and sludge)

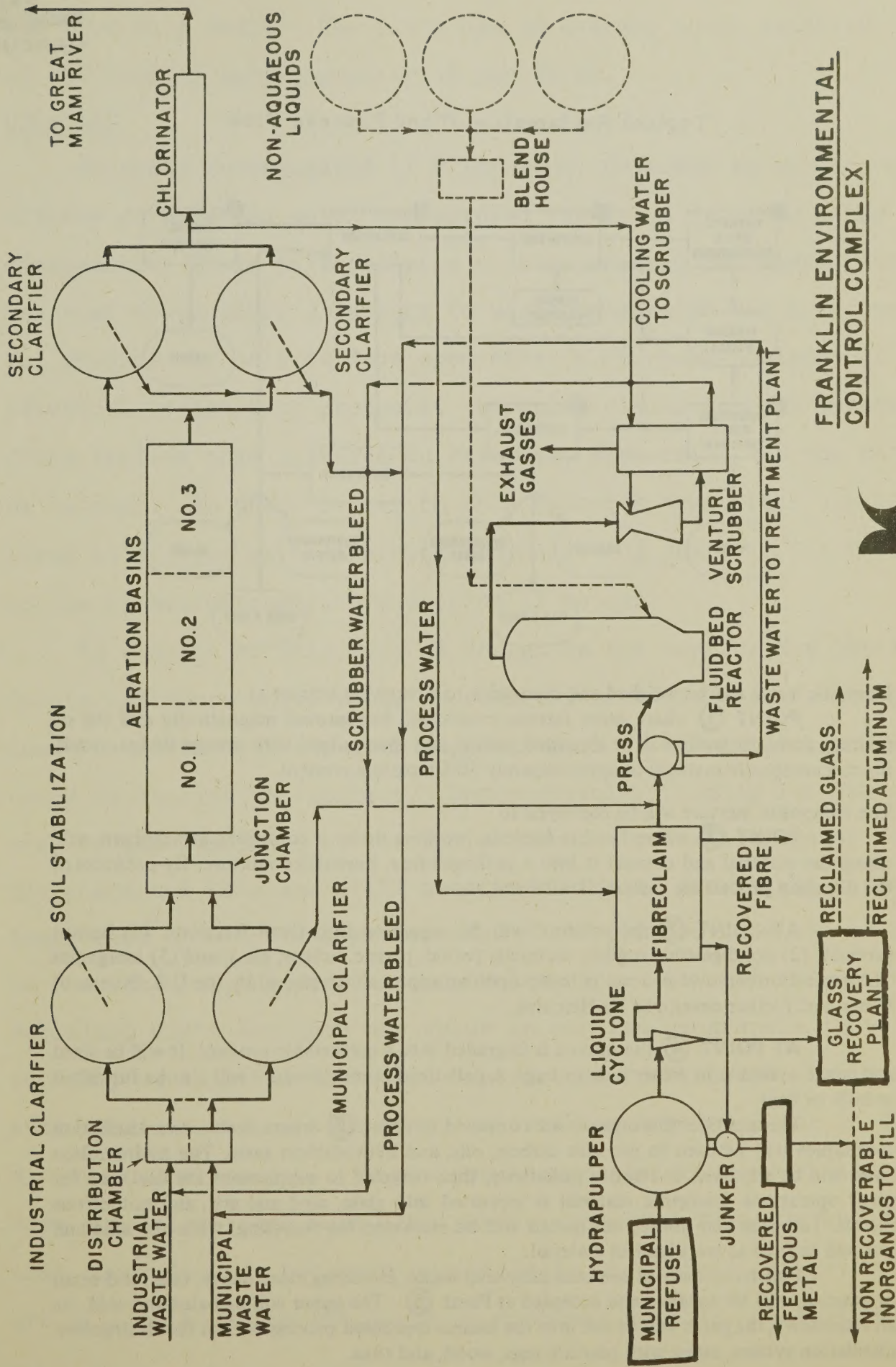
50 tons per day or 13,000 tons per year	\$23.40 per ton
100 tons per day or 26,000 tons per year	14.90 per ton
150 tons per day or 39,000 tons per year	12.18 per ton
500 tons per day or 182,500 tons per year	6.30 per ton

As you can see a facility such as Black & Clawson's would have to be 500 tons or more per day to be economical.

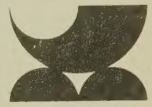
Representatives of Black & Clawson have approached Metropolitan Toronto suggesting they are able to conduct a feasibility study of the area in regards to whether their process is viable here but have had no reply as of yet. They have designed and are in the process of doing the groundwork for construction of a similar plant in Hempstead, Long Island which can separate ferrous metals and non-ferrous metals, glass, paper, cardboard and board. However, in the Northeastern U.S. there is really no market for secondary paper fibres so the Hempstead plant will burn the paper products to produce energy for fuel power. The plant capacity is approximately 2,000 tons a day. If markets were found for the reclaimed material, Black & Clawson claim the cost per ton would be \$5.50-6.50, not taking into account the energy that Hempstead would receive.

ISA PROCESS

The Industrial Services of America System utilizes standard equipment such as conveyors, shredders, compactors, compaction containers, containers hauling equipment and a specially designed pulverizer necessary to receive, separate, process and dispose of industrial solid waste systems. The main feature of this plant is its capability of accepting large volumes of all types of refuse, including bulky industrial output and the salvage of useful materi-

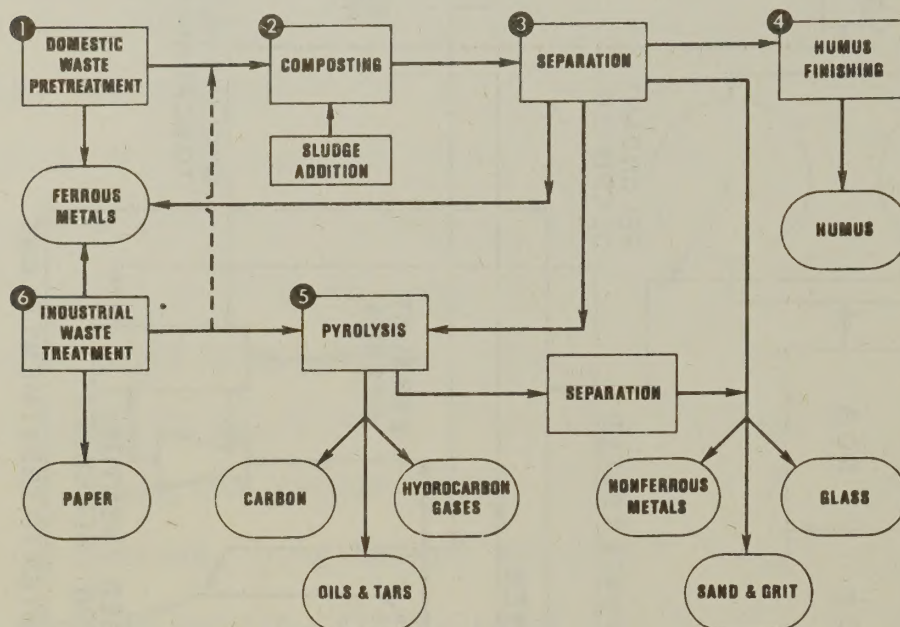


**FRANKLIN ENVIRONMENTAL
CONTROL COMPLEX**



The Black Clawson Company

Typical Reclamation Plant Process Flow



Domestic waste will be weighed and dumped into a receiving hopper at

POINT ① where most ferrous metals will be removed magnetically and the remaining domestic waste will be shredded, milled, and then pulped with sewage sludge, resulting in a composite material of approximately 50% moisture content.

The composite mixture will be conveyed to

POINT ② where aerobic bacteria, working under a controlled atmosphere, will digest the material and convert it into a pathogen-free, humuslike mixture. By-products of the digestion process are carbon dioxide and water.

AT POINT ③ the mixture will be separated into three fractions: (1) humus product; (2) nondigestible organic materials (wood, plastic, rubber, etc.); and (3) inorganics. The separation-removal process is based upon an approach developed by the U.S. Bureau of Mines, and further developed by Hercules.

AT POINT ④ the humus is upgraded into a marketable product. It will be sized and made available in either bulk or bags. A pelletized humus product will also be furnished in bulk or bags.

The nondigestible organics are conveyed to Point **⑤** where destructive-distillation techniques will be used to produce carbon, oils, and hydrocarbon gases. The hydrocarbon gases will be scrubbed to remove pollutants, then recycled to supplement the fuel used for plant operations. Inorganic material is separated into glass, sand and grit, and nonferrous metals. The glass and nonferrous metals will be marketed for recycling, while the sand and grit will be used as inert landfill material.

Full truckloads of selected industrial waste, including clean paper, tires, and scrap or plastics, will be weighed and accepted at Point **⑥**. The paper will be baled and sold. As an alternative, the paper can be fed into the humus-treatment process or into the destructive-distillation system, along with plastics, rags, wood, and tires.

als from this waste. The plant has an average total capacity of 200 tons of incoming material per shift.⁵

HERCULES

Hercules Incorporated of Wilmington, Delaware is another very diverse corporation which has entered the field of solid waste management. Their philosophy is that engineered processes afford the most responsible solutions to waste management and a successful process can only be developed after a thorough analysis of potential reclamation products. Hercules claims to have successfully applied this approach in Delaware, Wisconsin, and the city of Detroit. In their letter to this research team, they too offered to provide an engineering and marketing analysis for Toronto to use in evaluating future courses of action.

An example of this type of design is the one for New Castle County, Delaware which would process 500 tons of domestic and industrial refuse per day at a supposed cost of \$10 million and which could be doubled in capacity. Unfortunately, funding for the project was postponed by the Environmental Protection Agency for the state and they are still awaiting funds to finish the design. Their idea of a typical reclamation plant process flow can be seen in the accompanying diagram and explanation. Some of the materials reclaimed might not have any value in certain geographic instances but they could be landfilled. However, as you can see, it is a very closed system, where every material is accounted for in some different application. We realize that reclaiming everything is very unrealistic and most likely very expensive idea but it shows what technology is becoming available in this field, if governments are willing to spend the money on disposal methods. Unfortunately,

no estimate for a plant that is capable of handling Toronto's 4500 tons of solid waste per day was given. That's unrealistic too.

BUREAU OF MINES PROCESS

The Bureau of Mines in the U.S. is conducting several research projects related to solid wastes. One of them is based on utilizing the metallic and mineral values of incinerated residues. It's a good idea. For example, of the estimated 37 million tons of refuse disposed of by incineration, it was estimated that it contained more than 3 million tons of iron and 200,000 tons of mixed, non-ferrous metals.

INTERFLOW SYSTEMS LTD.

It should be mentioned in passing that Interflow Systems Ltd. of Hamilton is building a \$3 million waste product recycling and destructive plant in Saltfleet Township. The plant will break down industrial waste chemicals and organic refuse, reclaiming some products and disposing of the residue in a high temperature destructor unit. It seems to be a much better process than dumping into landfill sites and water courses. Interflow is also operating a thermal destructor unit which destroys spent oils, paints and other liquids in a gas fueled retort tube. Hopefully this means that there will be no more dumping of liquid waste at landfill sites.

This section has tried to show that the mechanical feasibility of separating materials is available and will be even moreso in the near future. This sounds like our problems will be solved. However, if we can cut down at the source, by decreasing the amount

generated, we can reduce the costs of installing these processes by reducing the total amount of waste produced. Now, even if that is done, the setting up of all these separation processes becomes totally useless, unless markets are set up to accomodate this growing supply of resources. Participation is necessary between all participating groups in solid waste management, of government, of private industry and of the individual. Industry must be willing to accept materials from solid waste through established dealers and brokers who can channel the flow of these goods back into industrial production.

We are not saying recycle everything because that is impossible but what we recommend is that any expanding urban area take re-use, reclamation and recycling into account. A city such as Regina would be unable to recycle paper but why shouldn't it try composting. A city like Hamilton or Toronto can recycle metals, glass and perhaps paper although it would be much better as fuel.

In any large metropolitan area as landfills become depleted, efforts to obtain additional space for disposal are thwarted by geographical limitations, as in Hamilton's case. Other methods than landfill have to be found such as incineration with power generation and reclamation. All these methods are capital intensive long-term solutions. Reclamation processes tailored to produce products soluble to local markets have the best potential, we feel, for achieving cost-effective solid waste management. This requires stabilization of secondary markets even perhaps through government legislation.

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PAPER

In Canada, "currently the majority of paper manufacturing processes draws from virgin raw material sources; this presents considerable stress on the forest base since approximately 17 trees are required to produce one ton of paper. Yet domestic, commercial, and some industrial wastes constitute an enormous reservoir of potentially recoverable paper materials." 1

It is interesting to note that the total production of pulp, paper, and paperboard from virgin sources in Canada in 1971 was about 17.5 million tons. Newsprint production claimed 45% of this, fine paper 3.4%, paperboard 10% and other finished products 41.6% (eg. corrugated cardboard, tarpaper, exported pulp). All of these were produced from virgin pulp resources and yet is there not a possibility of viewing waste paper and paper products as a growing resource in their own right? It has been said that as demand for paper increases, the paper industry will have to decrease its proportion of virgin pulp and increase secondary fibre use. Trees, although a renewable resource, have a minimum growth period. The conservation of these trees must be kept in mind and this could, even more importantly, work hand in hand to decrease the volume of waste with which municipalities must deal.

A resource management policy based on conservation objectives requires the adoption of an as near-to-possible closed system of material utilization in which all residues are reprocessed or otherwise made available for return to nature. Not only are most waste materials eliminated but marketing the valuable constituents of waste will produce revenue which can be applied towards the cost of solid effluent disposal. 2

If this type of policy were adopted waste would be viewed in its proper perspective...as this world's only growing resource, a resource with a very large potential.

In several reports which we used as references there is a section entitled, "The State of the Art". This refers to the state of the art of recycling. Recycling can be defined as the re-use of waste material; this is, however, practiced at three levels:

1. EFFLUENT RECYCLING: This consists of retaining and re-using by-products from the manufacture or processing of materials that are normally wasted. Level 1 recycling can be (but presently is not) accepted as an effective means of air and water pollution abatement. Waste in effluent is usually not potentially useful material, (eg. water, chemicals, clay, smoke).
 2. IN-PLANT RECYCLING: This second-level of recycling is the re-utilization of a manufacturer's scrap material from breakage or trimming. The material is still in the unspoiled state, namely, it is clean and of the same composition as the finished product. Level 2 recycling is almost universally done in industry as a cost reducing measure.
 3. RECYCLING OF POST-CONSUMER WASTE: Level 3 recycling is the re-use of contaminated wastes. This type of recycling is not carried out to any significant extent in any industrial sector. These contaminated wastes include used paper from offices and governments, cans and bottles damaged at a packer, newspaper over issue, etc. Reclaiming post-consumer waste represents a major solution to serious problems of solid waste management, like air pollution from incineration or leaching in landfill sites.
- Subheadings include:
- 1) direct re-use (eg. Eatons Catalogue for toilet paper)
 - 2) same thing (newspaper to newsprint)
 - 3) different thing (paper to cardboard)
 - 4) different form (paper for heat energy) eg. SWARU and pyrolysis

Little is being done presently in post-consumer recycling, although interest in this area is growing. The two primary waste paper contributors are packaging and newsprint. The former especially presents difficulties in recovery because packages so often represent a mixture of materials including wax, tars, plastics, metals, resins, and clays. These undoubtedly complicate separation and increase manufacturing costs. Even printed paper is 'contaminated' with ink and must be de-inked. It is a costly process and yet those companies which carry it out claim that it is economical.

Post-consumer recycling practices we noted vary greatly among the world's industrial nations. In those countries with vast forest resources only a small amount of recycling is done and vice versa. National percentages of paper recycled for some countries are:

TABLE I	Germany	44%
	Japan	37%
	Britain	36%
	Italy	36%
	U.S.A.	20%
	Canada	17%

(Taken from Recycling Project: Summer 1971, Pollution Probe, Toronto, p. 36)

Most of the 17% recycling in Canada is in the packaging field. The paperboard industry, which manufactures containers, has traditionally represented the largest single market for waste paper, and produces a little over 50% of all packaging consumed. Continental Can in Toronto claims to use "secondary fiber for up to 90% of all its total requirements" in its paperboard mill.⁴ Meanwhile, 28% of all secondary waste is used by the U.S. paperboard industry. However, this U.S. figure is found wanting when one considers that in 1960, about 42% of all containerboard was made from "combination board", made largely from recycled fibres. By 1970 this important market for waste paper had shrunk by 1/3.⁵

Corrugated cardboard in the form of shipping cartons uses up to 25% recycled fiber with an estimated re-use of 40%.⁶ This is one of the most easily instituted areas of recycling. Large amounts are readily available, and there are few problems with appearance or inks. It is significant to note that the Ford Motor Company in the U.S. sells all its corrugated boxes for recycling (100,000 tons/year) and has stated a purchasing preference for recycled packaging. However in Canada, while Ford Motors in Oakville sells all its cardboard, it specifies virgin material in all cardboard purchases, supposedly for strength requirements!⁷

Lightweight cardboard packaging, such as cereal boxes, often contain a high percentage of recycled fibres. The Canadian low grade paper industry (which manufactures paperboard, paper towels and roofing) also reflects a singular lack of concern about recycling issues. While both Scott Paper and Kimberly Clark in the U.S. use secondary paper fibres in their products, their Canadian counterparts⁸ do not.

There is certainly room for expansion in these areas. Corrugated containers and other paperboard cartons can be recycled directly into containers and packing products. Why aren't they in Canada?

Canada has only one mill, Abitibi Provincial, Thorold; that deinks fine paper to make new fine paper and no mills using newspapers to make new newsprint grades. The U.S.A. on the other hand has several of these, eg. Garden State. Thirty percent of the paper mills in the U.S. rely almost completely on waste fibres for raw material.

Although the overall use of recycled fibre would appear to have increased since the Second World War, it has actually decreased relative to the use of virgin fibre. This has resulted not only because of the increasing abundance of contaminants but also because of increased waste paper collection costs, technological advances in dealing with virgin wood fibre, and integration and expansion within the industry which have resulted in additions of virgin pulping capacity. Often when one thinks of recycling only the remaking of products is considered, (eg. newspaper to new newsprint, fine waste paper to new fine paper, etc.). However, it is not always the most economical procedure to recycle waste into its previous form. In some cases it may be more desirable to convert wastes to commodities of lesser value (eg. newsprint to corrugated cardboard). It may even be more profitable economically and socially to burn paper to produce energy in some situations. These are all things which must be examined very carefully before any paper reclamation project can be carried out properly.

From the company representatives with whom we talked and through the readings carried out we felt that more post-consumer waste could definitely be used if it were available in a constant supply. But the separation and grading of paper from municipal and domestic waste is very complex because of the heterogeneity of its content. Until very recently hand sorting has been the only method of separation used. Waste paper can be divided into forty individual grades but for simplicity's sake is often separated into four basic categories:

- 1) mixed paper, kraft wrapping, old corrugated containers, wrapping;
- 2) old newspapers and magazines;
- 3) waste from printers, envelope manufacture and
- 4) cuttings from box and bag manufacturers.**

(The basis

of this classification is the extent to which a given wastepaper is a source of paper fibre which can be used in the production of a paper with a high Mullen index (strength which is amenable to refining and possesses a high brightness index).**

TABLE II SUMMARY OF METHODS AVAILABLE FOR MUNICIPAL WASTE HANDLING

Unsegregated Waste

Segregated Waste

- | | |
|---|---------------------------|
| 1) Hand sorting
2) Mechanical Sorting <ul style="list-style-type: none"> a) eliminating putrescibles b) use of wet sort method (Black & Clawson) | 1) Hand sorting at source |
|---|---------------------------|

(Taken from Jacobs, H. & Biswas, A., Solid Waste Management: Problems and Perspectives, Environment Canada, Ottawa, March, 1972, p. 2011)

Since 1970 waste segregation at its source has been investigated further. In several cases, certain large industries such as office buildings, large retail outlets, transportation terminals, apartment buildings, and various salvage agencies segregate their waste paper and have it collected by waste dealers or brokerage firms. Often waste documents are shredded in order to preserve any confidentiality. Some institutions with large amounts of cardboard also bale and sell their waste cartons and boxes. The waste dealer or brokerage firms sorts, grades, and compacts the waste paper into 500-1500 pound bales. These are in turn sold directly to paper mills.

Another method practiced in a few municipalities is separate collections of paper and the remainder of domestic and commercial municipal waste. One study cites that:

...in the future, we are going to have to enlist the co-operation of the generator of our solid waste - the individual. The householder may be asked (and gently nudged by municipal regulation) to presort his refuse into several categories for pick-up...presorting of household refuse is working. It is working in Irvington, N.J. It worked in San Francisco. In fact, presorting has worked on a voluntary basis in every case where the opportunity has

been presented to the public. The majority of the people are concerned about preserving their environment and they will try to help. 9

In Canada, Ottawa, Kanata, Toronto, Edmonton, and a few other smaller cities have experimented with separate collection with varying results. The success or failure of these experiments often seems related to the method by which a segregated collection is organized, advertised, and carried out. In the next section we shall attempt to write a brief overview of some of the programs now in operation in Canada.

KANATA

The first municipally-sponsored paper collection in Canada began in 1970 in the small Ottawa suburb of Kanata (pop. 5,000). It began in November on an experimental basis with 50% participation and was made permanent four months later. Most of the organizational work for the project was done by Pollution Probe - Kanata, although it was financed by the March Township. Pollution Probe hired the private cartage firm and set up the collection routes. Support for the collection was solicited by door to door leafleting, advertisements in local papers, church and club bulletins, and public service announcements on television and radio.

All clean paper, including newsprint, magazines, brown paper bags, heavy corrugated boxes, and catalogues is acceptable. They are bundled and tied or placed in a cardboard box and left at the curbside for pickup. Collection is once a month on a house to house basis. The paper is sold to Florence Paper Co. of Ottawa for \$8-10/ton. (See table for comparison with other cities). The cost of

the collection, so far, is \$240 more than the revenue from the sale of the paper; but compared to the cost of dumping at \$4/ton, the collection has saved the Township \$400.

Since only 20 tons a month is collected, Kanata is interesting only because of the overwhelming public support it has received--60-70% participation which is obviously an essential part of a successful project. But it is also obvious that for an effective and useful project, not one that is just conscience salving, the collection must be successful in the larger Canadian cities--Ottawa, Toronto, Montreal, Hamilton--so that a large percentage of post-consumer waste paper is recycled.

OTTAWA

The impetus for Ottawa's collection came from the success in Kanata. In the summer of 1971 Pollution Probe-Ottawa, with an OFY grant, built several paper depots in shopping centers throughout the Ottawa/Hull area for the disposal of paper by households. An arrangement was made with a local salvage company to borrow their trucks for the pickup of paper from the depots for sale to the salvage company, that the company would maintain the depots, pickup the paper from the depots and keep a record of the amount of paper collected, in return for all the revenue from the sale of the paper. With this arrangement, 40-50 tons of paper were collected from the four depots once a week.

The city established a pilot project in October 1971. It ran for five consecutive Saturdays. The city was divided into four areas, each one was given a different Saturday for pickup. Collection was to be curbside at 7 am. There was door to door leafleting by the

sanitation men, as well as radio, newspaper and television ads. The division of the city into four areas caused confusion. People did not like putting the paper out the night before, for fear of rain, and 7 am. was too early to put it out on the pickup day. Furthermore, the public was not actively involved in organizing the project. This project was abandoned as a disaster. Hence, the city decided to try a different approach. In June 1972, a Citizens Committee on the Environment was created, with members from all interested organizations including the Boy Scouts and Pollution Probe. This committee was to design a new municipal paper recycling project. It was decided to equip temporarily some garbage trucks with 36" culvert pipe at a cost of \$500/truck.* The paper would now be collected on a weekly basis with the garbage. To insure the active support of the sanitation men, the loaders and drivers were given a pay incentive. Instead of delivering the paper to the salvage company, the company set up depots at the landfill sites, so the paper could be unloaded at the same time as the garbage. Any profit would go to the contractor who paid for the installation of the special racks on the trucks. As in Kanata, all clean paper was acceptable for collection (newspaper, magazines, heavy cardboard, brown paper bags). Again the collection was publicized through newspaper, television, and radio. The collection which started in June 1972 covers approximately 66,000 households. For the first six months of the project 96 tons of paper were collected a week. This is equivalent to 1 pound/person/week.

*This sounds like an excessive amount compared to Madison's price of \$170/truck for their paper racks.

MADISON, WISCONSIN

Madison's municipal paper collection is unique primarily because of its relationship to the paper industry. In 1967 the National Committee for Paper Stock Conservation (representing the paper industry), approached the City of Madison (pop. 170,000) with a proposal for the city to participate in a pilot project of collecting newspaper for recycling. The city was interested, as they considered paper salvaging a possible partial solution to their solid waste disposal problems. Their first concern with a paper collection was the availability of markets. They found three paper companies willing to buy one third each of all the paper collected. (Garden State Paper Co., which makes newsprint of 100% recycled fibres, was one of the firms).

The project was set up jointly by the Department of Public Works and the Paper Stock Committee. It was decided to start the operation only in the East Wards of the city in September 1968. An arrangement was negotiated with a local salvage dealer which guaranteed the City all the proceeds from the sale of the paper over \$14. The project was advertised by public-service messages on radio, ads in the local papers, news articles in the papers and by doorknob hangers. The Paper Stock Committee paid for the printing of the doorknob hangers, and the City paid for the distribution costs (\$2000). These hangers listed the information concerning preparation and kind of paper that was acceptable, as well as general information about the project. Public support was solicited primarily on the basis of extending the life of Madison's landfill sites and also to actively support recycling of paper and conserve forests. Participation was voluntary. An estimated 45% of waste newspaper is salvaged.

This indicates a good rate of support, but perhaps with a city ordinance, to further encourage participation, this rate could be even greater.

The collection was weekly on the same days as the regular garbage pickup. Due to the cost of having separate collection (\$42-61/ton for two man dump trucks and \$27.50 for one man truck), it was decided to put racks on the regular garbage trucks. The racks hold approximately 1 cubic yard. They were built by the City at a cost of \$11 in materials and \$70 in labor--far cheaper than the \$500 quoted by Ottawa. This difference in price could be because Madison's racks were built by the City whereas Ottawa hired a private contractor. This brought the cost down to \$22.28/ton. At the end of 51 weeks, the project cost the City \$25,000 above the revenue from the sale of the paper. But 3062 cubic yards of space had been saved at the landfill sites. Yet this in itself seems like a poor reason to continue the project. Landfill is not a long term solution to solid waste management problems. Although municipal paper collections do help deal with waste disposal problems, and should be pursued as a means of getting post-consumer waste paper recycled, they are only useful in conjunction with other solutions (eg. incineration with heat recovery or composting).*

It was decided to expand the project and make it City-wide. The paper industry paid for the printing and distribution of the doorknob hangers. The city-wide collection started in March 1970. Even after running a pilot project there were problems. The biggest problem was with the salvage dealer. The city had failed to arrange a set agree-

* See discussion of disposal methods.

ment with a salvage company. The problem was eventually solved by direct delivery to an out-of-town paper broker at \$6-8/ton.

During April, May and June 1970, 414 tons of paper were collected on the West side with a revenue of \$1228 or \$2.97/ton. On the East side 294 tons of paper were collected with a loss in revenue of \$1817 or \$6.18/ton. Combining the East and West sides, collection resulted in a loss of 83¢/ton and 236 tons of paper were collected per month. The primary difference in cost is that all the garbage trucks on the West side were equipped with the special racks. During both 1971 and 1972 a profit of \$4.66/ton was realized.

TORONTO

Toronto's municipal paper collection is the most recently established, starting as a pilot study in June 1972. So far it has been racked with problems and has overall been far from successful. The paper pickup is once a month and is separate from the garbage collection. The plan is on a city-wide basis, is voluntary, as in most cities, and only newspaper is acceptable for collection. The pickups are advertised in all the Toronto newspapers the Tuesday before the collection. It was decided by the City to have a monthly collection in order to reduce cost. The Commissioner of Streets, Mr. Atyeo, felt that the additional cost of \$60,000 to install racks on all the garbage trucks could not be offset by the sale of the paper. Even at Ottawa's price of \$500/truck for the racks, this estimate sounds excessive. Storage was an additional problem supposedly solved by the monthly collections.

The paper broker will not accept deliveries of less than 100 tons at a time and at the present, Toronto is collecting less than 200 tons a month. It seems odd that no other city has difficulties in dis-

posing of these amounts of paper. Ten percent of municipal garbage in Toronto is newspaper and less than 10% of this is being recovered. This means that less than 1% of Toronto's garbage is being recycled. The six collections from June to November...yielded 98, 156, 184, 225, 169 and 273 tons respectively. This is an average of 184 tons¹ (or 6.18% of the available newspaper). Somehow it seems ridiculous that a city of 700,000 is collecting about the same amount of paper as Madison a city of 170,000. (See Table). Mr. Atyeo, Commissioner of Streets, felt that at present the paper recovery was useless because all that is doing is taking the paper that has been collected by the Boy Scouts and other community groups and having the city collect it instead. No additional paper was being recycled. No additional paper could be sold. Yet TRAC (a sub-committee of the city Public Works Committee, made up of city officials and community groups) stated that "we are not even satisfying the offers for newspaper. Canadian Paper Fibres has offered to buy 800 tons monthly from the City, but we are averaging less than 200 tons in the monthly collection."² Unlike Ottawa, Madison, and Kanata, Toronto is losing money on its collection. (See chart). It is costing the City \$20/ton to collect the paper and Canadian Paper Fibres buys it from the City for \$5-7/ton.

It seems clear that the City government is creating a situation in which the paper recycling project must fail. The Streets department seems unwilling to accept the short-term deficit, which seems unavoidable in establishing the project, in order to have a successful collection running at a profit or, at worst, breaking even. Both Ottawa and Madison initially ran at a deficit mostly due to the cost of installing the trucks with paper racks. Although TRAC and Pollution

Probe has been vocally critical of the city's apathy toward the project so far the city has been ignoring their demands.

HAMILTON

A pilot paper reclamation project was run for $2\frac{1}{2}$ months from May 29 to August 16, 1971, encompassing 700 homes in Ward I of Hamilton (south of Aberdeen and west of Queen Streets.). Paper was picked up by two Streets and Sanitation trucks weekly on the same day as the regular garbage collection, but separately. A total of 4.1 tons of paper was collected in the 10 pickups (on two days the paper was too wet). The paper was sold to Mill Fibres, on Ferguson Street, Hamilton for \$8/ton or for a total of \$33. Total expenditures for the project were \$197.60 in collection, transportation and labour costs. This is a final deficit of \$164.60. As in Burlington and other cities the main difficulty encountered was in finding sufficient markets for the collected paper.

Having enquired about very active programs in some of the cities above, we also wrote to other cities throughout Canada, asking if they actively dealt with paper in any particular way separate from the rest of the garbage collected. Results were as follows:

BELLEVILLE: did not reply to our letter but a newspaper article on their recycling effort came to our notice. The city of Belleville collects newspaper once a month at the same time as a regular collection. The news writer felt that 15% cooperation was being reached and an average of 25 tons per month was collected from the city's 35,000 inhabitants. The collected paper is sold to Belleville Metal and Waste for \$8/ton and this dealer then sells it to Strathcona Paper Mill in Napanee for \$19/ton. The city is happy with these results and plans to continue collections with the hope of expansion.

CALGARY: was approached but no response was received.

EDMONTON: disposes of approximately 450,000 tons per year by means of sanitary landfill. The city of Edmonton itself does not collect paper for recycling but a local firm does. This firm has a number of portable bins which are spotted at various points throughout the city in conjunction with volunteer groups such as schools, church groups, etc. The groups themselves advertise the collection and people bring waste newspaper at this time. Each individual group receives the proceeds from their bin of paper. There is a market in Edmonton for approximately 20,000 tons of paper per year. This quota is presently being met although a small shortage of mixed paper and cardboard was experienced in 1972.

HALIFAX: a city of 121,00 in 1971, it collects its garbage once a week. All refuse is put out at the curbside and collected by rear-loading packer trucks. This collection costs \$11.84/ton. All refuse is disposed of by incineration at a cost of \$5.92/ton. Recycling of all types of paper is practiced by ordinance in Halifax and separate collection of all paper is licensed out to a private collector by the city. Any paper must be compressed, flattened, well-tied, and at the curbside and is picked up with private trucks on the same day as the regular garbage collection. Stores are also visited and paper and cardboard boxes picked up. The salvage company takes any paper to a warehouse, bales it and then transports it by train to Quebec City where it is recycled.

KINGSTON: reported that they disposed of their garbage in a sanitary landfill site. A short-term recycling project was carried out two years ago but nothing has been done since. It was assumed that "the trial was not a success." No mention was made of the nationally unique prototype Reclamation Plant proposed for Kingston and area. Designed by two Queen's professors, Dr.'s Clark and Brown, it was to be operational by now and would be the first of its type in Canada.

MONTREAL: informed us that they disposed of their solid waste by both sanitary landfill (city dump) and by incineration. The city itself does not carry out any separate paper collection although a number of private firms within the city do collect and recycle the following: "dead animals, paper and cartons, rubber, metal, and glass."

QUEBEC: no response was received.

REGINA: reported that all the city's refuse was disposed of by either sanitary landfill or incineration. The city collects commercial and residential solid waste while private contractors are allowed to pick up industrial refuse. They do not carry on any recycling of paper at present.

SASKATOON: reported that it did not separate any of the components of garbage at present. The city has approached the government of Saskatchewan about a pilot project in one of the city's collection areas. (This is a good way to investigate the problems of recycling). Paper, glass, and cans would be separated at the source. There has not been a decision on this as yet. The city's refuse is presently buried at a landfill site although the use of a shredder has been investigated. They stated: "Our major problem at the present time is the cost of freight haul to re-processing centres which makes recycling impractical from a monetary viewpoint."

*Perhaps Saskatoon, because of its geographical location, is not ideal for paper reclamation.

ST. CATHARINES: operates two sanitary landfill sites; one for putrescibles (household garbage) and another for non-putrescibles (refuse, brush, building materials, etc.). The putrescibles waste is pulverized before being land-filled. Groups in the city have carried on recycling programs but they have met with difficulties. They reported that "the problem lies in finding long-term stable markets for the materials, since without this, large scale recycling projects are not feasible."

*The problem of markets appears to be a primary factor in all recycling schemes.

VANCOUVER: collected 131,000 tons of refuse in 1972. With a commercial collection of 83,000 tons, a total of 214,000 tons of garbage was disposed of at a sanitary landfill site. No recycling of any kind is being done although they reported studies on shredding and other forms of volume reduction, composting, and recycling, etc. A component breakdown of the city's garbage included:

Paper	30%
Metal	17%
Glass	10%
Foodstuffs, Grass, Ashes	38%
Miscellaneous	5%
	<u>100%</u>

VICTORIA: no response.

WINNIPEG: no response was received.

After reviewing the paper reclamation projects in several cities, one can see that they have many similar problems. It seems clear that the project should be run first as a small pilot study, so any problems can be worked out before they become too expensive to deal with. Many of the cities ran at deficits initially, primarily due to the cost

of equipping the garbage trucks with racks, but also because of general difficulties and adjustments in collection procedures. Madison and Ottawa both started with separate paper collections, found this too expensive and switched to a weekly collection with the regular garbage pickup.* Whether the paper is collected with the garbage or separately seems to be a key factor in determining the revenue of the projects. Both Madison and Ottawa overcame the deficits after switching to joint paper and garbage collections, and Madison is now making a profit of \$4.66/ton. Toronto is unwilling to make this adjustment and is continuing to lose money.

Publicity is another element in running a successful operation. All cities used radio and television public service messages and newspaper ads. The knobhangers used in Madison seem a direct and effective way to appeal for support--people can't miss them. Advertising periodically after the inception of the project is important for continued support of people already involved and to encourage new participation.

Another way to encourage participation is a City Ordinance requiring separation of paper. Although all the cities discussed, except Halifax, have voluntary separation, an ordinance seems to be an additional means of appealing for support. This will encourage participation of people who are law abiding, but perhaps are not interested in recycling.

By far the most important factor in success of a paper recycling project is the availability of markets. Obviously, there is no point in separating and collecting paper if it is only to end up at the dump. Buyers should be investigated before starting any kind

*Kanata operates with a slight profit with monthly pickups but this may be so because of its size (pop. 5,000)

of collection. Markets will also determine what kinds of paper a city should collect. In Ottawa and Kanata there was a market for all types of paper, but in Madison there was only one for newspaper.

CITY	POPULATION	FREQUENCY OF COLLECTION	TYPES OF PAPER COLLECTED	VOLUME COLLECTED MONTHLY	LBS. COLLECTED PER PERSON PER MONTH	REVENUE PER TON
Kanata	5,000	monthly	mixed	20 tons	8.0 lbs.	\$8-10
Ottawa	302,000	weekly with garbage	mixed	410 tons	2.7 lbs.	Not avail- able
Madison	170,000	weekly with garbage	news- paper	230 tons	2.7 lbs.	\$6-8
Toronto	713,000	monthly	news- paper	184 tons	.5 lbs.	\$5-7
Belleville	35,000	monthly with garbage	news- paper	25 tons	1.4 lbs.	\$8

ABITIBI PROVINCIAL PAPER

In Canada one of the markets for fine paper is Abitibi Provincial Paper. Abitibi Provincial at their Thorold plant is the only mill in Canada which has a de-inking process for post-consumer waste paper, and this uses fine paper waste only. Rolland Paper Company in Quebec is the only other mill in Canada with these facilities, but they are inactive at present. Only Abitibi has the facilities for the de-inking process imperative in any large recycling operation, and the energy and initiative to expand their operations if markets permit. They have stated they would double the percentage of waste content in their paper if a demand existed.

Brokers in Toronto supply most of the paper, but dealers in Montreal and Buffalo also contribute. It does not have to be shredded beforehand, but does have to be sorted; it is then transported by rail.

The five types of post-consumer waste paper presently used at Abitibi, Thorold are as follows:

- i) coloured tab cards (computer cards)
- ii) coloured ledger paper (mimeo, duplicate, bond, book paper)
- iii) coloured manifold (business forms, cheques, invoices)
- iv) printed bleached kraft (cigarette package shells, TV dinner boxes)
- v) natural kraft (brown paper bags, kraft used between sheets of metal, etc.)

Newsprint is unacceptable for this particular process, due to the low quality, short fibres that would give fine paper insufficient strength.

Abitibi pays \$55-60/ton, and has a maximum capacity of 150-170 tons of waste per day. At present the mill uses approximately 100-125 tons of waste paper per day, or about 35,000 tons per year. This represents a 15% increase over 1971 figures. Of a 250 ton/day output, perhaps 90 tons of this would be of stock (waste), 11 tons of in-plant cuttings, and the rest of virgin kraft. There is about 20% shrinkage of the pulp after the de-inking process, 110 tons of waste paper would produce about 90 tons of recycled paper after processing. Domtar Fine Papers in Cornwall arguing the 'unviability' of the de-inking process, claims a possible 50% shrinkage if the expensive equipment necessary were installed.

While it is impossible to obtain reliable statistics on the cost of reclaimed materials as compared with virgin pulp, it is obvious that prices must be comparable for both Abitibi Provincial Paper and Garden State Paper in the U.S. to produce paper that is competitive both in price and quality.

Abitibi's mill has a primary effluent treatment (a settling tank), which yields a sludge of over 90% clay, used to coat bleached kraft, and is dried and trucked to a nearby quarry.* Though the effluent here

* It is interesting to note that the University of Guelph is presently investigating the possibility of composting this mill sludge.

is no worse than that of any other paper mill, nevertheless, the Ontario Water Resources Commission regulations should be more stringently enforced for all paper mills. Hence, the water used in the de-inking process at Abitibi should be returned to Lake Ontario at least in its original state (which is presently not the case).

The approximate percentage of de-inked fibre content in Abitibi's fine papers are as follows:

Olde Vale Antique	75%	Provincial Mimeo	45%
Glendale Antique	70%	Provincial Duplicating	40%
Hiway Tablet	50%	Hilroy (Seignory) Envelope	40%
Oxford Litho	50%	Bexley Litho	25%
Oxford Opaque	50%	Offset Enamel (Universal)	25%
Register Paper	50%	Paragon Offset	25%
Cavalier Print #8 Bond	45%	Paragon Brilliant	10%
Provincial Bond	45%	Weldonmere	10%

Remember, for each ton of recycled, de-inked fibre used, approximately 17 trees are saved!

ONTARIO PAPER

Other recycling operations are being attempted in Canada. For approximately 8 months in 1972, the Ontario Paper Company in Thorold used 35 tons/day of selected and over-issue newspapers, which was about 5% of mill production rate. Only high quality news was accepted to ensure against contaminants and unwanted grades, for which the mill does not have the necessary equipment. Canadian Paper Fibres of Toronto, a subsidiary of Buffalo Paper Stock Co., supplied the waste news. This paper was not de-inked, but pulped up and used as purchased. Some loss of quality as well as an increased cost for labor and brightening chemicals was experienced. Additional costs would also ensue in the area of papermaking felts, which filled up with the carbon and oils from the ink.

The Research Department of Ontario Paper is presently operating a pilot plant de-inking process to determine the feasibility of using large amounts, (200-300 tons/day) of post-consumer newspapers. If these experiments prove successful, the mill plans to install the necessary, and expensive equipment. It is imperative though that sufficient waste at a reasonable cost be available and assured, if this operation is to be economically viable.

GARDEN STATE PAPER COMPANY³

Only Garden State Paper Company in the U.S. is making a high quality newsprint sheet out of 100% secondary fibre consisting of printed newspaper. It operates mills at Garfield, New Jersey; at Pomona, California; and at Alsip, Illinois. These operations use approximately 400,000 tons/year of old newspapers, and so ease somewhat the problem of municipal solid waste disposal in some cities.

Garden State Paper is notable for the authoritative management of its operations. To stabilize the waste paper supply when the Garfield operation opened over 10 years ago, the responsibility of keeping the mill supplied was entrusted to two large paper stock dealers in the area. When the other two mills were opened, the corporation established its own paper stock brokerage firms to coordinate more directly the efforts of the many dealers in the area. Moreover, each small supplier was provided with an identification number to use on his bales, so that it could be readily determined who the supplier was, should there be a quality problem.

To stabilize further the price and availability of newspapers, Garden State placed a floor on the price it would pay for its raw material in the New Jersey and California markets. But more importantly, old newspapers in excess of that required by the mills are

warehoused at the firm's expense to support the market when other types of waste paper mills are not purchasing from the established supply lines. At one point, this entailed the purchase and/or lease of nine warehouses at an annual cost of nearly \$0.5 million.

Always concerned about quality newsprint, Garden State chose to work with its suppliers, through the brokers, to develop a special pack for which it was willing to pay a premium. This pack had to be free of magazines and other non-grade news grades, nor was there to be any tar on the bales. The company generally does not buy and use grades of secondary fibres such as ledger, book offset, soft shavings, etc. for reasons of quality and characteristics. Moreover, press room waste, white or printed, is not accepted. Garden State is also encouraging newspaper press rooms to use wire or paper rope material to tie the newspaper bundles, instead of the generally used synthetic and natural sisal-type ropes, which represent possible operating hazards.

The warehousing of substantial tonnages has had the added advantage of improving the general quality of incoming raw material, for it is possible, when there is an ample supply, bordering on overabundance of waste, to warehouse only the very best quality of special news. The development too of a prototype automatic sorting system will further streamline the 400,000 tons of raw material used each year.

Finally, the net effect of the de-inking process is to end up with a mixed furnish of groundwood and chemical wood fibre that has a higher percentage of long fibre than the original paper. Garden State paper generally has a higher tear strength, slightly lower mullen and tensile, but improved opacity and printing quality, and has been well received in most press rooms.

WASTE PAPER RECYCLING CHART

GRADE	RECYCLING USE	TYPE OF FINISHED PRODUCT
Mixed Paper	Roofing saturating felt	Tar paper for roofs
Magazines	Chipboard	Paper Cores for toilet paper, etc. Shoe Boxes
	Filler for Cylinder Board Grades	Food cartons like soap and cereal. Personal products like Kleenex
Newspaper	De-inked Newsprint	Printing Newspapers
	Insulating Board	Insulating Houses
	Back line for cylinder board grades	Same as for (Mixed)
	Building board grades	Building houses and inside walls
	Shedded Paper	Packing materials
	Molded Products	Egg cartons
Corrugated containers	Jute Liner Board	
	.009 Corrugated Medium	New corrugated containers (Boxed)
	For strength and drainage in cylinder board grade	Same final products as Mixed and News plus suit boxes, beer, solid fiber containers, carry-out cartons for cans and bottles
New Double Kraft	Same as for corrugated except higher grade	
Line Corrugated	uses or requiring less equipment	
Cuttings	Direct Kraft Pulp substitute	
Groundwood Shavings	Building Board (Plaster Board)	Building houses and inside walls
	Cylinder Board Grades	Same finished products shown for Mixed, Egg Cartons, Flower Pots, etc.
	Molded Products	
White News Blank	Ground Wood Pulp substitute	Ground wood printing papers
Publication Blank	Liners for cylinder board grades	Same products shown for Mixed
Hard White Shavings	Liners for cylinder board grades	Same products shown for Mixed
Hard White Envelope	White Core Stock-Fine Paper	Tablets, Printing Paper, Bond
No. 1 Book Stock		
No. 1 Flyleaf	De-inking grade for Book Paper	Printing Papers
Coloured Ledger		
White Ledger	De-inking grades for book and bond paper	Printing Papers Towel, Toilet etc.

Coloured		
Envelope	De-inking for tissue	
Manila Tab-		
ulating cards	Pulp substitute	For tissue, Printing Paper
Printed Bleached		
Sulphate	De-inking	Same products as Mixed
Cuttings	Liner for cylinder board	

*Compost Science, Vo. 12, No. 1, Jan.-Feb. 1971, Editorial

COMPANY	LOCATION	IS POST CONSUMER WASTE USED	TYPE OF PAPER WASTE	PRODUCTS	VOLUME OF WASTE PAPER	PERCENTAGE OF WASTE PAPER IN FINAL PRO- DUCT
Abitibi	Thorold	Yes	Mixed paper	fire (no newsprint)	100-125 paper tons/day	10-75%
Beaver Wood	Thorold	Yes	All Grades	gypsum (beer cartons, board computer cards, newsprint, etc.)	235 tons/day	100%
Ontario Paper	Thorold	Yes on trial basis*	Over-Issue Newsprint	newsprint	35 tons/day	5%
Great Lakes	Thunder Bay	No				
Consolidated Bathurst	Montral	Yes	Corrugated Containers	Packaging Products	110 tons/day	10-80%
E.B. Eddy	Hull, Ottawa		Incomplete Information			
Anglo- Canadian Pulp & Paper Mills	Quebec		No Response			
Strathcona	Napanee		No Response			
American Can of Canada	Rexdale, Ont.		No Response			

* Used on a trial basis for eight months in 1972.
At present research is being done using 200-300 tons/day of post-consumer waste newspaper.

FEASIBILITY FOR HAMILTON

Wondering if Hamilton possessed any facilities for the recycling of paper, we visited Mill Paper Fibres Ltd., the only paper broker in the city, in operation for about 75 years, and now employing 21 workers. The firm handles approximately 700 tons of newspaper and cardboard each month, or approximately 10,000 tons of all types of paper per year. It is sorted into 30 different grades before sale, and is collected locally at \$5-6/ton, or \$8/ton if delivered. Prices vary between \$17-20 when sold. Quantity and price vary however with mill demand. Newspaper, although it represents about 75% of total papers purchased by Mill Fibres, represents only about 25% of all available newspaper in the city. About 75% of the newspaper purchased by the firm is from local sources. Corrugated papers, Mill Fibres' second largest item is purchased at \$8/ton and sold for \$28/ton. Presently there is not enough in the area to meet the market, because 60% of it is being landfilled.* Hence, corrugated papers are being imported from the States to meet the mill demand.

Unlike Garden State Paper, Mill Paper Fibre is severely limited as far as warehouse space is concerned, and cannot stockpile beyond approximately one week's supply. Hence, the limit of newsprint from such an area as Burlington was stated to be about 20 tons/week. Mr. Whaley, the manager of Mill Fibres, also felt there was not a potential market for the amount of newspaper which could be collected in the Hamilton and Toronto areas each week.

It has also been argued that the major problem of newsprint recycling in this area, or anywhere else in Canada, has been the lack

* In Toronto, Simpsons and Eatons sell their corrugated boxes for recycling. This policy should be encouraged.

of a de-inking, re-pulping facility. This process would require a minimum of 350 tons of newsprint per day. Large capital expenditures, costly assembly, and costly collection procedures are other factors to be considered, as well as a good deal of marketing salesmanship necessary, to find the guaranteed outlets for the recovered processed pulp. At present, "sources are not dependable and markets on a wide scale are virtually non-existent." Even with all of these problems, paper mills are attempting these recycling operations.

From this information then, we know that paper containing various percentages of secondary fibres is available in Canada. Though the U.S. is much ahead of us in this regard, markets have been created and sophisticated mills designed to meet the demand for recycled paper, some organizations in Canada are consciously using secondary paper waste. Prices and quality remain comparable, however, for both virgin and recycled, de-inked, paper products.

McMASTER UNIVERSITY

Mr. F.O. McGuire, Printing and Publications Officer, is personally responsible for McMaster's use of recycled, de-inked post-consumer fine paper. McMaster adopted this policy about $2\frac{1}{2}$ years ago, and was one of the first universities to do so.

Seventy to seventy-five percent of all McMaster's major paper is recycled, de-inked waste. This includes all envelopes¹ and a high percentage of the computer paper used in the computer centre. The price and quality remain comparable however, for both virgin and recycled, de-inked paper products. This paper is purchased from the Abitibi mill at Thorold through two distributors in Hamilton; Barbara Ellis of Canada Limited and Buntin Gillies and Co. Ltd.

1 All the envelopes bear a logo indicating the use of post-consumer waste paper. We feel this is a good policy as its use is thereby brought to the attention of the public, and allows a complementary comparison of quality.

With regard to the possibility of collecting waste paper within the university for recycling, Mr. P.F. McNichol, the Assistant Director, Operations and Maintenance advised that the operation was uneconomical because of high labour and transportation costs. We believe on the contrary, because of the volume of paper used internally at the university, it is an ideal setting for pre-sorting and collection at the source. This could operate on a similar basis as that already operative in some large office buildings. Computer cards and print-outs are already being recycled at the university. This is possible because there is no need to separate the materials. Mill Fibres Ltd. buys the paper at \$8/ton delivered, or at \$5-6 pick-up.

CANADIAN GOVERNMENT

Mr. Gleeson, of the Printing Operations Branch of the Department of Supply and Services, Ottawa advised that this department operates to a great extent as an intermediary between other departments and suppliers. Unless the requesting department specifies otherwise, the Department of Supply and Services will make no special effort to specify recycled paper on its orders. This effort has occurred in several instances however, when the Department of the Environment specified recycled paper for certain publications.

It is argued that the main reason why the Government does not use large amounts of recycled paper is that there may be difficulties of supply if such paper is specified in orders. While the Department of Supply and Services does state that up to a certain percentage of recycled paper will be accepted for certain uses, this is nearly always mill scrap (broke). (Clearly, preferential buying of de-inked, post-consumer waste paper is not encouraged, and it should be). It was also

pointed out that the availability of paper for recycling varies from mill to mill and from time to time. Thus those companies close to cities might be able to produce recycled paper easily, while those in the north could not meet these specifications. Two additional reasons tauted to argue the unviability of change are the fact that only the Abitibi mill in Thorold has the necessary de-inking equipment, and hence a limit of supply options could be a problem and the subsequent pollutants from the process of bleaching inks etc.

However, the Government does specify that it "will accept" up to a certain percentage of 'post-secondary' waste in such things as cardboard and liner paper. It has many different requirements for paper, from scratch pads and letters to fancy books and maps. Some uses require certain levels of whiteness, of stiffness etc.; characteristics hard to guarantee with recycled paper.

BELL CANADA

By February 1, 1973, both the envelopes and, in most cases, the account statements were manufactured from recycled, post-consumer waste material, and marked in important step in Bell Canada's paper pollution abatement programme.

This recycled paper may be defined as paper containing a substantial proportion of waste paper fibres either de-inked or non de-inked, or a mixture. By post-consumer waste, the company means paper collected from former users, not counting the trimmings and leftovers from paper mills.

Since late 1971 Bell Canada has been using such stationery items as letterheads, etc., in its internal operations, from paper containing recycled material. But the consumer accounts and envelopes are the biggest project to date in its environmental programme.

RECOMMENDATIONS

- 1) All cities should run a small pilot project to consider the feasibility of instituting a paper recycling project on a city-wide basis, as a partial solution to solid waste disposal problems. The object of this pilot study would be to seek markets for the collected paper, to determine what types of paper should be collected (eg. newspaper or mixed paper), to work out procedural problems of pickup and disposal (use of private contractors or public for collection), and to determine if this type of project is practical at all (eg. impractical due to geographic location).
- 2) The Department of the Environment should establish a committee to gather information on all recycling projects and uses of reclaimed paper by paper mills in Canada and act as advisor and provide initial financial support to any city desiring to establish a paper recycling project. This committee would also act as coordinator between industry and the cities in establishing future recycling projects.
- 3) The Federal and Provincial governments should actively encourage paper mills to expand use of post-consumer waste paper in paper production by use of preferential taxes for paper containing a high percentage of post-consumer waste paper.
- 4) Stimulate demand potential for recycled paper by the elimination of discriminating specifications, and the actual use of secondary fibres by those presently using only virgin material. To this end, all levels of government and related businesses should use recycled paper - for internal use, income tax forms, Air Canada publications, and so on. Moreover, this paper should bear a logo stating both that secondary fibre has been used, and the percent-

age contained. As F.S. Crysler writes in TAPPI, "we need to make business, government and the public aware that secondary fibers can provide functional requirements to meet their specifications." (p.909)

- 5) A municipal ordinance should be created to encourage both public participation in recycling, and to stimulate the individual to separate his paper in cities where there are municipal paper collections. The success of this method has been proven during wartime, and recently in Halifax, N.S. and now only needs to prove its efficacy on a larger scale.
- 6) Re: separation of paper refuse at source, at the domestic, industrial and commercial levels. Paper at these levels is easy to separate, exists in high percentages, can be easily recycled, and is a financially valuable resource. But once this paper becomes part of that amorphous body of garbage, and contamination ensues, the expensive technology required to "purify" it produces an end product which is no longer economically viable.
- 7) The thrust of the recycling efforts must be changed from the "supply - push" approach to one of "demand - pull". The use of secondary fibres should become a social priority, a process in which Canadian Paper Mills could and should contribute a great deal of knowledge, encouragement, and guidance. The paper industry is the one who knows the potential uses of secondary fibres in paper and other products and they ought to educate visibly and vocally the public with its usefulness. As was the case with the Garden State Paper Co., N.J., the mills themselves ought to have created a demand for secondary fibres, lead the way in planning the most efficient methods of paper collection, and act as their own brokers.

THE ISSUE OF RECYCLING

Since World War II, the percentage of secondary waste fibre used has decreased significantly, from a high of 35% to a present level of about 18.7%.¹ In turn, there has been a large increase in the use of wood pulp. Compounding this deficiency is the example in the U.S. where the population is increasing at the rate of 1% per year, while municipal solid waste is increasing at the rate of 4% per year.² Paper in its many forms is the largest single component of municipal waste, averaging 50% by weight, and nearly 70% by bulk.³ Although only 13-15% of all solid wastes is discarded packaging, this constitutes between 60-70% of all domestic waste and litter.⁴ In 1970 paper use, led by the packaging field, hit a peak of 500 pounds/person/year. Americans used 58 million tons of paper in that year, and recycled less than 20% of it.⁵

Canada consumes very little waste paper - only 4-6% of the total production. This is so, not only because in excess of 70% of the total produced is exported and thereby enters the solid waste stream of other countries, but also because newsprint is the major paper production to date, and uses almost no recycled, secondary fibres.⁶ Moreover, when one considers that urban refuse normally contains 40-50% paper and paperboard products;⁷ the issue of recycling becomes an urgent one.

It is also very much an economic one. At the moment, there are obvious advantages to virgin fibre over reclaimed material. As the problem is described in TAPPI (The Technical Association of the Pulp and Paper Industry - magazine), "virgin fiber pulping is a complex but straight forward high-production process with reasonable unit costs. Processing secondary fibres, although simple in principal,

is vastly complicated by high nampower needs and ever increasing quantities of such contaminants as plastic-coating pressure-sensitive adhesives and hot-melt adhesives.⁸ In addition, the paper machines used for virgin fibre grades are two to three times as wide and fast as the cylinder machines used for many recycled fiber grades. Conversion rates too are noteably higher for virgin than for secondary fibers. Hence, the paper industry for the past two decades has chosen to invest its' capital in wood pulping mills. Moreover, paper mills, designed for the use of virgin materials, are not easily converted to recycling mills. They are also often located far outside cities, where 80% of the population is located on 20% of the land, yet precisely where recycling plants are most necessary. Finally, because they represent considerable financial investments in their present locations, it seems realistic to assume their continued operation as virgin fiber paper mills.

In short, virgin fiber is in a form that can be used at once by a paper manufacturer, is clean, of uniform colour, and has not lost any fiber strength. On the other hand, waste paper must be treated and in turn suffers a reduction in the properties of the individual fibres. Thre is also the problem of residual contamination, when recycled paper is used for milk cartons, ice-cream containers, egg cartons, meat trays, etc. The reclamation operations would therefore require many in-plant modifications and fulsome capital expenditure to handle this waste. However, "the facts about laws concerning waste and virgin materials need to be determined; then it must be decided if they are valid in light of rresent-day standards of health quality control."² Moreover, the de-inking process often

produces a highly alkaline effluent, full of dispensing agents and great water pollutants. And in the end, the re-claimed fiber has a lower tear strength than virgin fiber.

Finally, about 12% of all papers produced is unrecoverable, now in permanent use in books, or building materials, burned in fire-places or lost as tissue in sewage systems. Not only economics but some functional requirements militate against the use of secondary fiber, as for example in the area of frozen food packaging. But this need not be true in the dry food, hardware, toy, detergent and other areas. Economic vicissitudes also affect the utilization of mixed paper waste. Recently the demand for roofing paper and other construction grades has declined⁹-and these grades account for the largest consumption of secondary fibers. Of significant concern too are the wholly questionable and unwarranted purchasing specifications on many orders, such as presently practiced by the Canadian Government and its' businesses, which specifically prohibit the use of secondary paper waste.

Clearly, positive steps must be taken if a change is to be effected in recycled fiber utilization, and new uses of waste paper are to be found. In the first place it must be as economically viable (or even moreso), to use secondary fiber as it is to use virgin pulp. At present, however, the high labour costs involved in the heterogeneous separation of waste, the cost of cleaning this contaminated material, and its common combination with other materials for which another process altogether is required, results in an end product which is simply not economically competitive. At the same time, penalty taxes will not encourage the use of recycled material, because it has

been repeatedly shown that industry only incorporates this increase into the final price of the product, and it is the consumer who unwittingly must pay this tax. Nor will new collection and sorting methods really effect much change. Instead, concerted action is required in three areas:

(1) Only when recyclable waste is prevented from ever becoming mixed with that encompassing mass of garbage can it be feasibly processed. When, for example, the wet separation system was evaluated by the Container Corporation of America, it was found that the high level¹⁰ of residual contamination made it unfit for widespread use. Separation of fibrous waste at the level of home, office, and plant is therefore imperative.

(2) The expansion of existing paper stock operations would also increase the volume of recycled paper. F.S. Crysler, writing in TAPPI points out that its Pioneer Paper Stock Division, with little capital expenditure, could increase the amount of waste paper processed by at least 50%, simply by running an additional shift, rather than¹¹ the present one.

(3) The third area of concern must be the individual himself. As a main generator of paper waste, he must be encouraged (albeit by municipal regulation) to presort his refuse. Not only has this method been successful during wartime, but it is presently working in Madison, Wis.; in Chicago; in Irvington, N.J.; in Burlington, Ontario, and elsewhere.

Hand in hand with individual support must go a greater overall support of recycling and hence the creation of new markets. TAPPI describes this support as "eliminating specifications which discrimi-

nates against recycled fibers and the actual use of recycled fibers by those presently using only virgin fibers." ¹² In this regard, the demand potential can be immeasurably stimulated by a government change in purchasing specifications. Some, if limited action, has already been taken in this area. The General Services Administration in the U.S., for example, is encouraging the use of some secondary waste in its paper and paperboard products. New York City is also specifying recycled fiber for one paper grade it uses. Bell Telephone is recycling its telephone books in New York City, and uses secondary fiber paper for all its billing purposes.

A number of organizations in Canada (Algonquin Wildlands League, The Canadian Audubon Society, Bruce Trail Association) are specifying recycled paper in their purchasing orders and other large businesses are considering its uses (such as University of Toronto Press).. Even ¹³ Pierre Burton's The National Dream was printed on recycled paper.

What is of special importance however, is the active role an organization like TAPPI and the Paper Industry in general, can play. With its superior technical resources, TAPPI is in a strong position to provide the information needed to determine maximum recycling levels, and to explore the many possibilities of fiber utilization. There is a dearth of knowledge about secondary fiber resources, as opposed to the plethora of chemical and physical information about virgin fibers and their use--and this deficiency could be remedied. Research into new products which can utilize recycled fiber must be encouraged, in addition to the use of more secondary fiber in products now fashioned only of virgin material. In turn, the consumer too must be prepared to accept these products. Above all, organizations like TAPPI can make the issue of recycled fibers a socially acceptable concern.

Conclusion

Recycling of post-consumer waste paper - this poor bastard relation of the paper industry - must be given its social and economic rights. Then the utilization of secondary fibers on a large scale can be a tenable, and highly desirable reality.

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METALS

Beverage cans are not yet a major portion of the soft drinking beverage container, but are increasingly being used by the consumer. Today 20% of all soft drink beverage containers are of non-refillable metal cans.¹ Cans are convenient for both the soft drink supplier and the retail outlet. For the supplier it means a one way container which does not have to be picked up, cleaned and also saves storage space while the retailer is relieved from handling and provided with extra storage space.

Cans (food, beer, soft drink and others) account for 6.4% of litter.² Most of these cans, containing valuable metals, usually end up in landfill sites as well as incinerators. Cans are not quick to decompose, taking anywhere from 10-20 years or even more depending on the metallic composition. Most cans are bi-metal (tin-steel) with the exception of soft drink cans. Since cans do contain valuable metals, can they be reclaimed and recycled?

For proper and effective recycling, specified conditions must be set forth to coincide with the processes which are in operation now. These are separation and cleanliness of the can. The method for recycling cans is to melt down the can with other ingredients to make raw steel ingots. For the can to be recyclable the tin must be removed and the aluminum decreased to an acceptable level. The tin must be removed because it tends to contaminate the recycling process by forming hard spots, and creating subsequent difficulties in rolling the steel.³ The aluminum must be decreased to an acceptable level because excessive amounts of aluminum raise the temperature of the molten steel, both which may shorten the life of the refractory furnace linings.

M&T Products of Hamilton, a subsidiary of American Can are presently reclaiming cans. They are primarily in the detinning business and accept most tin-plate products. M&T processes 30,000 tons per year of clean tin-plate material. In-plant waste from can manufacturers accounts for 15% and the other 85% is from various industries which use tin-plate, to a certain extent scrap dealers and also some environmental groups. The price for tin cans and other tin-plate material is \$20 per ton and \$10 for scft drink cans.

Detinning involves washing the steel and placing the steel product in 500 pound batches for an alkaline or caustic process which removes the tin. Eighty-five percent of the tin is recovered. The tin is either sold for two dollars a pound or used in making a potassium standard. Most cans have lead soldered seams which is percipitated as a heavy metal. The lead in the sludge is sold to dealers. After the detinning process the tin free steel is sold to steel industries.

There is a certain amount of tin as well as aluminum which remains in the steel product. The metals do not pose a problem because the amount of tin left in the steel product is about 0.03% and the steel industries will accept up to point 0.06% tin content. M&T specifically asks and reclaims cans with as little aluminum content as possible, but the small amounts of aluminum that there is can usually be dissolved in the detinning process. Larger amounts of aluminum than acceptable can foul up the tin recovery process. The steel industries will accept up to $1\frac{1}{2}\%$ aluminum content in the steel, which they use purposely for the raising of the steel temperature.

Copper can also be extracted from cans. This is done by dumping iron ore on large piles of scrap cans and a dilute solution of hydro-sulphuric acid is percolated through the pile. The precipitated copper is washed off, decanted and ⁵smelted. This process is used primarily in the United States.

Soft drink cans pose certain problems for recycling. Soft drink cans are not strictly a bi-metal can (tin-steel) but also contain significant amounts of aluminum. A soft drink (zip top) can contains anywhere from 11-20% aluminum as well as a lead soldered seam.

American Can Company have reclamation centres for soft drink cans throughout Canada, but they are used almost solely by can workers who drop their cans off on the way to work. In the Hamilton area 20 tons were reclaimed during the peak year 1971, and were sold to their subsidiary M&T for five dollars per ton. M&T handles about 1,100 tons of soft drink cans per year, which are baled and sold to steel industries. The cans do not go through any process but are simply added in small amounts to steel batches where the steel is usually used for bridges and hence, is not likely to be recycled. The problem with soft drink cans is that they are too bulky and expensive to transport. It takes 22,000 cans to make a ton and these soft drink cans have to be separated from other tin-plate steel materials.

In the United States the amount of tin in a can is decreasing, moreover, the seams are processed through an electrolytic seam closure without the use of tin or lead. There have been two important experiments conducted in the United States by the National Steel Company and the Carbonated Beverage Container Manufacturers Association, where steel cans were processed into lower grade steel and

500,000 scrap tin-free steel cans were remelted into primary steel. National Steel has also performed experiments with bi-metal cans and has demonstrated that recycling is possible with mixtures of steel and tin.⁶ National Steel is also experimenting with the shredding of cans and magnetically separating the tin and steel from the aluminum, usually used as the tops of cans. It must be remembered that these experiments have only been recently undertaken and the data is yet to be conclusive. Therefore, we must confront the problem as it exists today.

A problem exists with the soft drink can. Despite the continual assurance by the can industry that the can is being recycled there is evidence to the contrary. In Hamilton, the can industry contends that the cans are removed magnetically from Hamilton's Solid Waste Reduction Unit (SWARU), sent to M&T Products where they are detinned, then sold to the steel industry and made into new cans. The SWARU is presently not operating successfully. Cans are being separated at SWARU along with 25% paper, aluminum and other metals. Since the steel industry will only accept metal cans with a 3% paper content and 1½% aluminum content, the cans in their present state are useless, troublesome and end up in landfill sites. SWARU is only able to handle 300 of Hamilton's 750 tons of garbage at present, so that less than half of the cans in garbage are being recovered, and they are not being reused.

The cans that are being reclaimed by M&T Products are in-plant waste cans from the different can manufacturers in Canada (and, mainly the Ontario and Montreal areas). Therefore, there is relatively zero municipal reduction of cans in Solid Waste. Cans cannot be recycled into new cans. What little use that is made of

cans in the steel industry is in the making of raw steel ingots and bridge parts and other secondary steel products, which are unlikely to be recycled again.

Reclamation of cans is practically non-existent. American Can does have can reclamation depots but are very rarely used except by can employees and the volume size of the depots is minimal. Transportation costs far outweigh the profit level. It takes 22,000 cans to make a ton (almost $\frac{1}{2}$ of train car) and they are purchased for \$10 per ton. Since Hamilton has the only detinning process, cans would have to be sent to Hamilton from other parts of Canada, a scheme which would be economically unfeasible because of their bulk. Further, the metals in the beverage cans limit their use in the steel industry, tin contaminates the steel. A content of more than $1\frac{1}{2}\%$ aluminum can be harmful to the ovens and lead is unfavorable in steel producing. This further limits the can's potential of being recycled.

Despite the recent experimentation and the statements of the can industry, it is evident that the can is far from being successfully recycled. If the can cannot be recycled in its present state and methods, what are the alternatives to reduce the amount of cans in solid waste?

RECOMMENDATIONS

1. That the government encourage industry to investigate recycling techniques and possibility of new and better disposal methods.
2. That soft drink beverage cans be reduced or eliminated until the can and recycling methods are devised to make the can 100% recyclable.

3. That more depots be set up by the can industry to accomodate all cans used in a household and that a refund be given.
4. That home separation of cans be encouraged until disposal systems are able to separate the cans from solid waste.
5. That the can industry begin producing an all steel can with an electrolytic seam closure.

Scrap metal use has become an integral part of the Canadian steel industry. Canada is a net exporter of steel including scrap, consequently steel and foundry industries encounter scrap deficits, and Canada ends up importing as much as 27%¹ of their scrap requirements. The following is a table of a five year study of Canadian industries scrap consumption (in tons).

YEAR	TOTAL SCRAP USE	PURCHASED SCRAP	IMPORTED SCRAP	DOMESTIC SCRAP CONSUMPTION	TOTAL	TRADE BALANCE
1965	6,983,633	3,565,944	1,020,798	2,545,146	2,806,816	-758,128
1966	5,242,795	2,712,821	717,717	1,995,104	2,317,151	-395,670
1967	5,938,803	2,611,572	563,669	2,047,903	2,507,212	-104,360
1968	6,350,998	2,709,740	641,208	2,068,532	2,528,223	-181,517
1969	6,198,531	2,857,391	711,851	2,145,540	2,912,206	- 54,815
1970	6,810,100	3,001,193	827,473	2,173,720	2,895,267	-105,926

Source: Dominion Bureau of Statistics

In the United States, 45% of iron and steel, copper and brass, 59% of zinc and aluminum and over 50% of lead are obtained from secondary sources.² These figures are comparable with metal recovery in Canada. There is a large market for recycling metal products and the demand for scrap metal has the price per ton fluctuating constantly.

The primary source for scrap metal is the automobile. It is estimated that there are about 400,000 tons³ of abandoned and scrap automobiles throughout Ontario. There is on the average 1000-1200 pounds of salvageable scrap on an automobile.⁴ The average cost per ton of automobile is anywhere from \$23-30 per ton but once the transportation, separation and shredding operations are performed, the cost may be as high as \$45-50.⁵ Despite the costs, automobiles remain the main source of scrap metal, and actually as high as 40% of all scrap metal used by the different steel industries. The metallic composition of an automobile varies depending on quality; the following is a metallic composition of a 1954 Chevy: Iron - 2726 pounds, Copper - 35 pounds, Lead - 21 pounds, Aluminum - 8 pounds,⁶ Zinc - 41 pounds and a trace of nickel and chromium.

There are certain effects on the environment caused by automobiles. The main health hazard incurred through junked cars are the formation of rat colonies and breeding grounds for bugs, especially mosquitoes. The metals have an effect on the earth. The copper found in autos may possibly affect plant growth; lead is very toxic as are nickel and chromium in small amounts, and zinc may also restrict plant growth. Iron and aluminum have little effect and are unlikely to leach as are the other metals. The leaching problem with these metals is limited because the leaching process is very slow. Yards with good drainage experience limited ecological change. The main complaint is that these areas are used for junked cars but could be used for something else. The non-metallic components of the auto also pose a certain problem. Consisting of rubber, plastics, fabric and cardboard, these non-metallic elements are not yet feasibly

recycled (excluding cardboard) and are difficult to dispose of. Tires are usually just piled up and left, as are plastics. The other sources of metal recovery are bulk appliances (stoves, fridges), dismantled bridges, in-plant waste, and whatever metals scrap dealers come up with.

There are four major processes for scrap metal recovery which is either used by industry or scrap dealers:

The most common process is the shredder. It rips whole auto body frames into small pieces of metal. Shredders can rip up to 120 autos per hour. If the shredded scrap is separated either magnetically or by hand, it will be easily cleaned and free of copper and other non-ferrous contamination. Procter Steel Corporation, USA has developed a shredder which can remove lead, solder, rubber, dirt and glass. The final scrap steel product is quite attractive to the steel industry. Shredders are expensive and have high maintenance costs, despite this, some scrap dealers collect cars from as great as a 500 mile radius and find it economically feasible.

Bailing is a popular and simple method. Metals are either put into an incinerator or separated by hand where the contaminants are removed then the metals are compressed into cubes.

Two more recent processes which are used today are the shear and the air classifier. The shear operates on the basis of compressing the metals into logs where they are cut into small lengths. This allows the scrap to be easily inspected and transported.

The air classifier is the newer method. Materials are subjected to an air classifier where heavy and lighter metals are blown into a "bag house". This is an extremely efficient method as 96% of the metal is recovered and 84% of the non-ferrous materials are rejected

There are three types of furnaces in the steel industry which use scrap. These are the old type open hearth furnaces, the basic oxygen furnace (BOF), and the electric furnaces which are used mainly by the smaller steel industries. The open hearth furnace is still predominant in the steel industry but is being quickly replaced by the basic oxygen furnace. The open hearth furnace commands 60% of the steel industry as compared to 25-30% by the B.O.F. and 10-15% by the electric furnace.⁸ The open hearth furnaces uses up to 40% scrap. The B.O.F. only uses 15-20% scrap content in steel processing but the small percentage used by the B.O.F. furnace is counteracted by the electric furnace's use of 100% scrap in steel making.⁹ Both the B.O.F. and electric furnaces are making steady inroads in the steel industry. The electric furnace may not become predominant in the near future but its increasing presence will necessitate the use of more scrap.

The benefits of the electric furnace may not be fully realized yet but the fact that it is being increasingly used by industrialized nations (especially Japan, Germany) demonstrates that it has promise. Lasco Steel Company of Whitby uses the electric furnace. They have their own broker, shredding and separation processes. The different metals are separated magnetically and placed on train cars which are shipped into the furnace area. Lasco Steel uses 1200 tons of scrap a day in their steel making process.¹⁰ The final product made by Lasco Steel are steel rods, angles and grader blades. The auto industry is the primary purchaser and they are also used in bridge construction.

Most of the smaller companies remain competitive because of the process of continuous casting. Continuous casting increases yield as well as decreasing implant waste. The type of steel produced through continuous casting is limited but technological improvements are expected to overcome the limited steel products which are continuously cast. Traditional methods of steel making require 158 tons of raw materials for every 100 tons of steel with 73 tons being scrap, which about 37 tons of scrap is purchased the remainder being in-plant scrap. With continuous casting only 60 tons of scrap are used but in-plant scrap is only 19 tons, necessitating the purchase of an additional 41 tons of scrap. The result is an increase in the scrap demand of 11%.¹¹ With continuous casting being as efficient as it is, many larger steel industries are beginning to convert to this method and the demand for more scrap will increase thereby prompting secondary material dealers to improve collection methods and handling processes.

With Canada importing 27% of its scrap requirements it may be necessary for scrap dealers to look at new markets. One of these markets may be municipal waste. A Quebec study estimated that 6%¹² of garbage produced annually per household is metals. Most metals in garbage usually end up in landfill sites and are very rarely reclaimed. There are new disposal methods which claim municipal waste separation and the recovery of certain materials such as glass, metals and plastics by the Black Clawson method. Hamilton, Ontario has its own disposal unit known as the Solid Waste Reduction Unit (SWARU) which is supposed to separate and reclaim metals. Despite the continual assurance of Mr. Sutin from SWARU and Mr. Rogers of M&T Products that this an effective and profitable operation, it is

quite evident that SWARU has fallen short of its expectations. Mr. Sutin is quite correct when he says that metals can be magnetically reclaimed but what he does not state is that there is also 25% paper and a percentage of aluminum which is unacceptable to the steel industry. The metal and steel industry can only accept 3-5% paper content, 1-1 $\frac{1}{2}$ aluminum content and 0.06 tin content.¹³

M&T Products is in the detinning business and will be able to extract the tin. To handle the paper and aluminum content, M&T is to add another step in the reclamation process. This will involve the adding of another magnet which will initially pick up the metals which are travelling along the conveyor, putting them through a "flickering" motion which is supposed to drop most of the paper caught in the metals as well as a certain amount of aluminum, then dropping the metals. These metals will be picked up by a second magnet and put on another conveyor which will deposit them in a specified area. This metal deposit area presently looks like a mountain of paper, since 25% of it is dried paper remains. It is yet to be seen if this new process is to be successful. Another drawback of the SWARU is that presently it only handles 300-350 tons daily of Hamilton's 750 tons of daily garbage. Thus, more than half of the metals in Hamilton's municipal waste end up in landfill sites.

It is evident that scrap is increasingly needed in the steel industry, especially with the current drain on natural resources. Technological advancements have made scrap metals 100% recyclable by the steel industry. It seems that it would be both profitable and ecologically sound if a concerned effort was put in reclaiming metals from municipal solid waste.

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GLASS

Clear or flint glass is made from sand, soda ash, limestone and calcium carbonate. Flint glass may be coloured by adding oxides of chromium, cobalt, iron, nickel, carbon and sulphide or sulphur to make the glass amber, emerald green or royal blue. Cullet, which is mostly discarded in-plant glass, ground up, and sometimes post-consumer glass, is added to the raw materials in the furnace and melted at a temperature as high as 2800 F. Cullet will melt at a slightly lower temperature and the other raw materials will stick to it for easier melting. Post-consumer cullet is collected from depots outside the plant. Clear glass must be separated from coloured glass because it is an expensive process to de-colour the glass, so coloured glass may only be used to make more coloured glass. The amount of cullet generally used in the production of new glass is about 25% with the same amount of cullet that can be added to the melt, since more than about 30-40% will cause undue brittleness of the glass.

Glass can be formed into sheet glass for windows or can be used for light bulbs, reflecting glass, mirrors, ornaments, decorations, tableware, containers and many other products. Here we will be primarily concerned with container glass because it can be most easily recycled. As a container, glass is used in packaging food, beer, liquor, wine, soft drinks, cosmetics, toiletries, pharmaceuticals and chemicals. These containers have the advantage in that they can be clear so the consumer can see what he is getting or coloured to protect the product from the sun's rays. Glass containers are air-tight when well sealed and impermeable so that they will not absorb or affect the odour and taste of the contents. Some containers can be re-used and as such they are easy to wash and sterilize.

PROBLEMS WITH GLASS IN THE SYSTEM

Of all the glass produced there are only two types of containers that are made to be used more than once; the returnable soft drink bottle and beer bottle. The returnable soft drink container is being gradually eased out and is being replaced by the non-returnable soft drink bottle and the can. If the current trend continues, experts predict that by 1975, all soft drinks will be sold in non-returnable containers. Most glass containers can be resold to glass manufacturers for $\frac{1}{2}$ cent each or \$15 a ton. Only a very small number of bottles are returned to these depots and consequently most containers are thrown in the garbage, or even worse, become litter.

SOLID WASTE DISPOSAL OF GLASS

Glass presents some very serious problems in disposal. Broken glass is a health hazard to garbage collectors, since it can cut through paper and plastic bags that are so often used to contain garbage. It contributes to the weight load of garbage significantly and even if it is properly crushed it adds volume to the waste load. Glass does not decompose in dumps and landfill sites and if it is not properly crushed it can trap dangerous gases and create air pockets. If they are not cleaned (in almost all cases they are not) the sugar residue in bottles will attract insects. Glass hinders the incineration process. In some incinerators, glass will bond to the firebrick and must be removed manually which may cause damage to the brick surface. Glass will remain as a part of residue in incinerators, about 45% in most cases. Unlike most other forms of garbage (paper, plastic, food wastes) it does not produce heat when burned, therefore, it cannot be recycled as fuel or heat energy.

Glass in Litter: The Glass Container Council of Canada has said that glass composes 3% of litter. This is by whole bottle count, not by pieces of broken glass and this amount excludes broken glass from automobile windows and lights. It is the broken glass that causes the problems in litter and the fact that it is an eyesore is important too. Unlike paper packaging, which is found more abundantly in litter, it does not decompose, and just sits there until it is picked up. It is costly to the taxpayer to pay for the clean-up and for the automobile owner when a tire gets punctured by a piece of broken glass. Small pieces of glass can magnify the sun's rays and cause forest fires.

Glass as a Health Hazard: Disposable glass containers are thin-walled and break easily if dropped. The (U.S.) Commission on Product Safety "has noted that a study of 2582 insurance cases closed over a three month period in 1969 indicated that glass bottles injured more people than any other home product...430 of these cases involved glass bottles including at least 27 that exploded." ³ The contribution of broken glass in litter to foot lacerations is hard to assess but many people have complained to the government after being cut by pieces of non-returnable bottles. Farmers have complained that their animals have suffered from broken glass and small pieces of glass have been found in the stomachs of a variety of animals, ranging from chickens to fish. Farmers in the prairies cannot use the hay planted near the highways for cattle feed because of all the broken glass it contains.

The problems that glass containers present in disposal are not incurable. There are two solutions being considered at the present time: recycling and reduction at the source. The relative merits of each are discussed below.

SOLUTIONS

1. Recycling

Recycling is a way of reintroducing waste materials into our system of consumption. The glass industry is currently utilizing three methods of recycling: in-plant waste recycling, the returnable bottle, and post-consumer recycling.

In-plant waste is composed of bottles that have been formed in the regular process but must be discarded because of some imperfection. Virtually every industry recycles its waste in this way. The waste glass is crushed and is used in the production of new glass containers.

The returnable bottle was the original container for products in the beer and soft drink industry. As the non-returnable container, or disposable or convenience container became more prevalent, the use of the returnable decreased drastically. The beer industry recognized the fact that if beer bottles were standardized, handling and other costs would be minimized, so that all beer bottles became standard and returnable with only a small amount of competition from the non-returnable container. The soft drink industry, on the other hand, decided to increase the number of non-returnable containers because they produced a larger profit and today the returnable container for soft drinks is in danger of becoming extinct. The returnable vs. non-returnable container will be discussed in the next section.

The third type of recycling, post-consumer waste, has been in existence for a long time. During the Second World War, waste glass became extremely valuable for munitions production. People separated their glass from the rest of their garbage and it went to the muni-

tions factories where 50% old glass and 50% raw materials were used. For many years after the war, when people were still conscious of every penny they spent, they saved bottles and jars for preserving, and since pop came in returnable bottles only, there was very little glass thrown away. Now that the age of affluence is upon us, we do not save bottles and jars for preserving (who makes their own anymore?) and all our non-returnable bottles and jars are casually tossed in the garbage. What we are now beginning to realize is that the age of affluence and disposable packaging really means overwhelming amounts of garbage, and constantly decreasing supplies of natural resources.

Unlike the paper and metal industries, glass manufacturers do not have to worry about the availability of most of their raw materials. They feel that there will be enough sand to supply the industry for a long time but soda ash is becoming harder to get. They have become involved in recycling because of the disposal and litter problems. Most glass manufacturing plants in Canada and the U.S.A. have set up depots at their plants where members of the public may return their glass containers and are paid $\frac{1}{2}$ cent each or \$15 a ton. Unfortunately, this sum is not large enough to appeal to many people (for \$15, almost 4000 10 ounce non-returnable containers would be required) so most of the glass comes from small fund-raising groups like the Boy Scouts, and environmentally concerned groups which have set up recycling centres. The bottle returns represent only a small part of the new glass container production. The glass container industry has investigated the possibility of using waste glass for other secondary products, since the production of glass containers can not absorb a large amount of additional post-consumer glass.

The following are some of the secondary products that may make use of some of our waste glass:

Glasphalt: Studies at the University of Missouri show that glass fragments may be substituted for stone aggregates in asphalt. The glass material will perform as well as conventional pavings made of sand, stone or rock. They are looking into ways to make the paving water resistant.

Aerated Concrete: Ground glass can be used as a filler for asphaltic concrete to replace the limestone dust. It is found to be a superior fill and presents no problem in handling.

Glass Bead: Soda lime glass is used commercially to make glass beads for use in reflective paints for highways.

Wool Insulation: Mineral wool insulation can be manufactured commercially using up to 50% waste container glass.

Foam Insulation: Studies are being done to develop a foam product from waste glass which has both chemical and physical durability.

Wall Panels: Glass can be used as the binding agent and glass content can range from 13 to 94%. This material has a high compressive strength and has very little water absorption.

Building Bricks: Bricks have been made using 80% clean waste glass with 20% clay binder.

Tiles: Tiles may be made of a mixture of 50% glass and 50% clay, mineral plasticizer or sewage sludge. The glass glazes the tile when heated to make it highly water resistant. In terrazzo flooring, glass can be used to replace marble chips to make the tile cheaper and harder.

The addition of waste glass to building materials tends to increase its strength and water resistance.

There has been a recent development from Pittsburg Corning Corporation of a small cellular and light weight glass nodule which absorbs oil resulting from spills in water and allows it to burn off without polluting the underlying water.

Although these products are still in the experimental stage, they appear to be potentially good markets for waste glass and glass seems to be a good or better substitute for the original materials. However the cost and energy requirements for such products must be considered. For example, the cost of stone aggregate for asphalt is around \$2 to \$4 a ton; the cost of waste glass is \$15 a ton. Also, "...if waste

glass is used to replace crushed stone in making asphalt, the ratio⁶ of the energy increment is sixty to one in favour of using stone." So we see that these products do not offer a very realistic solution to the problem at these costs.

Still, the glass manufacturers are encouraging recycling, and they are able to use the small amount of post-consumer glass that is presently being recycled. To be recyclable, glass must be separated from the rest of the garbage either at home or after collection.

Many environmentally concerned groups have set up depots where individuals can bring their bottles and jars (usually without remuneration) and it is separated, smashed and sold to glass manufacturing plants. The problems with these depots are plentiful. When the cost of advertising, sorting, storage and transportation is considered, these depots usually operate at a break even basis or even a loss. The labour is voluntary and participation usually involves only a small part of the population. One such project, done by Clear Hamilton of Pollution came to the following conclusions:

"We are now able to see the enormous discrepancy between the reasons why we should be concerned about solid waste management, and the reasons why anti-pollution groups are presently involved in recycling. This gap must be dealt with. We must realize that the reasons for the popularity of physical recycling do not in themselves justify the continuance of such projects by volunteer organizations. There must be an accompanying ecological or political justification."⁷ *

A few communities have tried collecting glass curbside after it has been separated by the homeowner. These are often sponsored by the municipality, provincial government and/or private funds. Pollution Probe in the town of Kanata, near Ottawa, is being sponsored

*Using Scortex techniques.

to collect glass and paper for purposes of recycling. They ask residents to separate glass by colour, remove any metal or plastic and place it in a cardboard box at the curb. They collect about six tons of glass per month and are finding increasing public support. Although they run at a deficit of \$4 to \$6 a ton per month for paper and glass collection, with the cost of regular municipal collection at \$10 to \$14 a ton, they are saving the city a considerable amount of money.

In Burlington, Ontario, the Citizen's Committee for Pollution Control was sponsored by the provincial and municipal governments to run a similar study to assess public interest and the costs for separating wastes in the home for separate collection and recycling. Although they found that they had a very large degree of public participation (70%) and a 60% recyclable separation, their collection methods were so costly that they spent four times the revenue received. They do believe that with better collection methods they would have been more successful financially.⁸

An alternative to home separation is sorting glass from refuse after separation. At present there are only two methods of glass sorting being done at disposal units: hand sorting and optical sorting. For hand sorting, unsorted or partially sorted refuse is placed on a conveyor belt, and as the garbage goes by employees pick out the glass. A method such as this will be used in the proposed total reclamation centre in Kingston, Ontario.* Unfortunately, this method is dangerous and unsanitary and very costly due to high labour requirements. In the view of the Minister of the Environment, hand picking is an undesirable element except as a temporary process in a purely experimental operation.⁹

* See disposal methods - Total Reclamation Centre

The optical or magnetic sorting method is currently in process at only one plant in the U.S.A. The Glass Container Manufacturers Institute is sponsoring a glass sorting operation at the Black Clawson Hydrasposal plant in Franklin, Ohio.* The system works in this way:

A slurry containing paper fibre, organic material, most of the glass, small pieces of metal, ceramics and much of the aluminum is extracted. The inorganic and heavier metals are removed by centrifugal action, this being about 80% glass by weight. A process developed by the Sortex Company of North America and the Glass Container Manufacturers Institute, separates aluminum and colour sorted glass from the inorganic residues. This concentrate is dried, screened, magnetically separated and air classified. The pure glass fraction is sorted into flint (clear), amber and green in a Sortex optical separator. "Following the glass separation process, which is 50% efficient, is the glass decontamination and sorting process which is 60% efficient. Thus 30% of the glass in municipal waste can be reclaimed for return to the container maker."¹⁰

Glass can be separated from incinerator residue by sifting out the ash. This glass cannot be used as cullet for new glass containers without further processing.¹¹

At this time the separation of glass from refuse is a greater problem than finding markets for used glass. Home separation of glass for manufacturing plant depots is not encouraging enough for large amounts of glass to be returned. Environmental groups who set up reclamation centres are doing admirable jobs, but participation is low though public enthusiasm is high and problems are great. Sortex techniques are still in the experimental stages at

*See disposal methods-Black Clawson.

this time and are costly, lacking in efficiency and extremely energy consuming. The most reasonable approach at this time is municipal pickup of pre-sorted glass. This would involve a high public participation (90% of the people from Hamilton who answered the questionnaire said they would be willing to separate glass from garbage.) This does not necessarily mean that 90% will separate glass.

Although the economic aspects are still essentially unknown, small pilot projects should be established and adjusted to fit the needs of the city. If other recyclables (metals, paper) were collected along with the glass, the worst that could happen would be a slight decrease in collection costs. It is very possible that by a decrease in landfill costs and with profits from the sale of these materials, collection costs could be offset. The glass companies and bottlers who sell these disposable items, have a moral obligation to pay some collection and disposal costs. Since the city would have far less garbage to dispose of, it would ultimately save money. As an alternative, the glass container manufacturers and bottlers should set up more convenient depots for the public with higher prices for used glass as an incentive.

Reduction at the Source

Here we will be concerned with glass containers: soft drink bottles (returnable and non-returnable), beer, liquor, wine and juice bottles. The provincial government after realizing some of the problems created by glass packaging, has set up a subcommittee of the Provincial Solid Waste Task Force to deal with beverage containers. The rather unique situation with soft drink containers compels interest in this area and has caused the committee to deal with this problem in particular. Soft drinks first appeared on the

market in returnable bottles. Even with a small deposit, bottlers got an average of about 20 trips from each bottle. In 1956 cans were first introduced as soft drink containers, but did not gain prominence until 1962, after many changes in the cans were made and a lot of money was spent on advertising. In the mid 1960's the non-returnable (or "throwaway") bottle was introduced and although it never gained as high a share of the market as cans gained, it has about 15% of the Canadian market with a larger percentage in Ontario. Meanwhile the trippage of returnable bottles dropped considerably. The Ontario average is nine trips per bottle at the present time but even at that rate the returnable bottle is far more economical than the non-returnable.

COST ANALYSIS

Type of Container	Returnable 10 oz.	Non-returnable 10 oz.	Bi-metal (tin, steel) 10 oz.	Tri-metal (tin, steel, aluminum) 10 oz.
# Trips				
1 trip	8¢	3.5¢	3.8¢	4.2¢
5 trips	18¢	17.5¢	19.0¢	21.0¢
9 trips (Ont. ave.)	30.5¢	31.5¢	34.2¢	37.8¢
20 trips	47.5¢	70.0¢	76.4¢	84.0¢

"Trip" for non-returnable containers means the number of bottles produced for an equivalent trippage of returnable containers.

The energy consumption for non-returnable bottles and cans is higher than for returnables. Energy consumption for one 16 oz. returnable bottle (eight trips), eight 16 oz. non-returnable bottles and 12 oz. cans for one gallon of beverage. *

ENERGY ANALYSIS

Container	With Recycling	Without Recycling
Returnable Bottle	20,050 BTU	20,840 BTU
Non-returnable Bottle	57,520 BTU	61,620 BTU
Bi-metal Can	54,120 BTU	

* Recycling energy using Sortex techniques.

Aluminum or zip-topped (tri-metallic) cans are 36% more energy consumptive than bi-metal. Non-returnable bottles use three times as much energy as returnables with recycling and 2.88 times as much as returnables without recycling.

Non-returnable bottles are a large contributor to the litter problem. By virtue of the fact that they are meant to be disposable, they will inevitably be disposed of in the wrong places. Returnable bottles, in the unlikely event that they are littered, will stand a good chance of being picked up by someone else for the refund. Non-returnable bottles are more likely to be broken in litter since they are thinner-walled, weigh less and are made to withstand less pressure than returnables. As broken glass, they are more likely to be a health hazard and dangerous to automobiles. Mr. Gordon Taylor, (highways minister for Alberta) said: "the (disposable) bottles left on highways are a nuisance and a hazard, with the onus of cleaning up resting on the shoulders of the taxpayer."¹⁴ He also said "it (the returnable glass bottle) is far less likely to shatter when thrown out of a car onto a highway, it is strong enough to remain intact when subjected to the weight of a rubber tired highway service vehicle...and more often than not, it remains intact when thrown into a river or stream around camping grounds."¹⁵

Cans make up 6.4% of litter in Canada. Disposed of in the wrong place, cans can cause leaching and can present a health hazard when sharp and rusty. Metal cans will eventually decompose, but if they have plastic coatings (all pop cans do) they take longer and aluminum tops take about thirty years to decompose. Glass will not decompose, so these non-returnable containers will have to be picked up at the expense of the taxpayer.

Non-returnable soft drink containers contribute to the cost of garbage disposal. A ten ounce returnable bottle weighs .98 pounds. If it makes five trips and is thrown out, it contributes only .98 pounds to the solid waste load. A ten ounce non-returnable bottle weighs .6 pounds. Five non-returnables thrown away will add three pounds of garbage.¹⁶ In Metropolitan Toronto, non-returnable soft drink bottles and cans cause over 100 tons of garbage every day¹⁷ costing the taxpayer \$2,500 daily for collection and disposal.

On the whole, returnable bottles are a much more practical container for soft drinks than the non-returnable bottle or can. Cans present even more problems in that they are using up valuable resources, especially tin which is one of the most scarce metals. They are also very difficult to recycle. (See Metals section).

After considering the problem with the non-returnable container, the Minister of the Environment gave the Task Force three optional regulations to consider. One is a complete ban on non-returnable drink containers. Another would require a refund on all types of beverage containers, returnable and non-returnable. The third proposal involves setting a minimum deposit level on re-usable soft drink, beer, wine and spirits containers and levying a tax on non-returnable containers.

Most consumer and environmental groups prefer the first alternative as far as soft drink containers are concerned: an outright ban on all non-returnable soft drink containers. Let us look at their reasons:

- 1) Returnable bottles are cheaper than non-returnable bottles and cans if used more than five times.
- 2) Returnable bottles use less energy than non-returnable bottles and cans.

- 3) If non-returnable bottles and cans are banned, there will be a decrease in the solid waste and litter loads.
- 4) The consumer does not want, need or demand the non-returnable container.
- 5) Recycling costs and energy demands are too great at the present time to return large amounts of glass and metals into the system. Technology into separation methods is not sufficiently developed.
- 6) Jobs will be gained by banning non-returnable beverage containers.*
- 7) Retailers will be willing to handle returnables if changes are made to standardize bottles.
- 8) The consumer will gain an awareness of the problem of solid waste and wasted resources in our system.

The two other alternatives are scorned because they will not necessarily solve the problem. The second alternative, a refund on all containers, returnable and non-returnable, may eventually compel all bottlers to use returnable bottles. But until then there will be returned containers that are not refillable that must be dealt with. Unfortunately many of these containers will end up in landfill sites. This is what happened in Alberta when refunds were paid on all bottles. It is unlikely that markets will be found for this used glass since it is so expensive to recycle and the energy costs are so high. In Alberta, even Dominion Glass Company would not take the used glass. They required that all impurities (metal and plastics) be removed, a costly and uneconomical task.

The third alternative, a tax on all non-returnable soft drink containers, is likely to cause more problems. To begin with, it is unlikely that the tax will make much difference to the consumer. It has been found that a few pennies in additional cost is not likely to affect consumption. Secondly, the retailers who dislike handling returnable bottles, will be able to reduce drastically their stock of returnables and force the consumer to pay the tax on

* See Appendix I.

non-returnables. A provision could be introduced that required all stores to offer a returnable of the same size and brand as any non-returnable they sell, but it would be almost impossible to police. Finally, although the industry itself will be taxed, they will assuredly pass the extra cost on to the consumer, and probably a little bit more too. This is in effect, selling the public a licence to pollute and condoning the production of polluting goods by the industries.

Most people who prefer the ban recommend that the returnable bottle be standardized in size and shape and even colour. Retailers say that they dislike returnable bottles because of sorting and handling costs. If the bottle were standardized into one shape, perhaps like the present beer bottle, it would be cheaper to produce, more compact for storage, more efficient for washing, and more easily packed in larger cartons for distribution and sale. Sizes of soft drink containers should be reduced to two or three, and colours should be reduced to two: clear, and brown or green. These changes would reduce the handling costs for the retailer. With the deposit on returnable bottles now 5 and 10 cents, the return rate of the bottles should be high enough to guarantee to the retailer no loss on refunds and with a present mark-up on returnable bottles of over 15%, handling costs can be paid, with money left over for profit.

Standardization will make a big difference to the bottler. Easier handling, washing, filling, and shipping; but it will also mean a loss in the trademark of a bottle with a specific shape and size. When the brewers changed from specific to standardized bottles with a large paper label to identify the brand, they found the system

so good that they denounced a non-standard bottle introduced by Carlings as a "backward step". To the consumer, standardization will mean easier price comparisons, lower costs, and particularly if cartons are supplied with the bottles, easier storage and returnability. Standardization could mean a decrease in the surface area of the bottle, and when it is eventually thrown out, it will mean less of a problem in disposal.

Beer, Wine, Liquor and Juice Bottles

Any recommendations made by the Task Force will also apply to beer bottles, liquor and wine bottles and other beverage containers (juice bottles). The beer industry introduced its own returnable system several years ago and has been so successful that many hope the soft drink system can be set up in the same way. Beer is sold in standard sized and shaped returnable bottles with only a very small percent of sales in cans. They have a very high rate of return on bottles, probably because of the carton supplied. A small refund is given on cans that are returned, which are sent to steel industries for re-use but are not made into new cans. The refund system on cans is not economical and must be subsidized.

The liquor and wine industry is somewhat more complicated because of the fairly large sales of imported products in Ontario. Liquor and wine bottles are a large share of waste and more glass containers are sold to these industries than the soft drink industries. All liquor and wine bottlers should be encouraged to sell their products in bottles that are standard and returnable. The provincial government should disperse grants to those Ontario bottlers who wish to change their system to returnable and tax those who do not. This would encourage foreign bottlers to use a container

that could be re-used in Ontario. At the same time, it would allow the consumer to choose between the standard bottle and the higher priced fancy bottle. The tax money collected from the non-standard, non-returnable bottle should be used to offset the litter collection and disposal of these bottles. This puts the responsibility in the consumer's hands, not the taxpayers. Those who choose the product for the container, will be responsible for disposing of it.

If Ontario were to take this stand, then many other provinces and states in the U.S.A. which have been considering similar legislation, would most certainly follow, thereby encouraging foreign bottlers to use a common standard. Since it would be too expensive to ship foreign bottles back to their respective countries for refilling, bottle production in Canada would have to be flexible enough to allow foreign made bottles to be absorbed into the Canadian system. This would prevent a surplus of returnable bottles.

Although sales of other beverages in bottles are small in comparison to the soft drink, liquor, wine and beer sales, they too should be standard and returnable. Some companies are selling juice in pop bottles, and this seems to be gaining in popularity since it allows for higher profits.

Consumption of Containers in 1969: \$19.3 million - soft drink manu-
facturers
\$21.7 million - distilleries
\$10.1 million - breweries
\$ 4.8 million - wineries

Dominion Bureau of Statistics - Consumption of Containers and Other Packaging Supplies by the Manufacturing Industries. Cat.No. 31-502

Recommendations:

- 1) That all soft drinks and unconcentrated juice be sold in standard sized and shaped returnable bottles of not more than two colours; clear and green or brown and not more than three sizes. That the deposit on these bottles be not less than the cost of these bottles.
- 2) That the Ontario government offer grants to the liquor and wine industries in Ontario that wish to sell their products in standard returnable bottles of not more than three colours and three sizes. That the Ontario government impose a tax on all domestic and foreign liquor and wine bottles sold in Ontario that are not standard and returnable and that this tax be used to offset the cost of litter collection and disposal of these bottles.
- 3) That all beer be sold in standard returnable bottles of one colour and one size.
- 4) That the Province of Ontario consult with other provinces and states of the U.S.A. to determine bottle standards that would be acceptable to all, should they wish to adopt the standard system.
- 5) That cartons be provided whenever possible for beverages sold in bottles, to facilitate handling and storage.
- 6) That the municipal government encourage home separation of recyclable materials and that industry provide municipalities with financial assistance in collecting recyclable materials separate from other garbage. That the industries involved be encouraged to use as much secondary material in the production of new material as possible.
- 7) That the provincial government and industry further investigate uses for recycled materials and separating and sorting techniques.

8) That the Provincial Government appoint a special placement office to investigate the creation of new jobs within the industry, and to ensure the re-employment of those affected by the changeover, without any loss in pay or benefits, and, if necessary to provide re-training.

Appendix I

A considerable number of jobs have been eliminated by convenience packaging, According to the Crusade for a Cleaner Environment (1900 L Street N.W., Suite 301, Washington, D.C. 20036):¹

...If the current trend continues, experts predict that by 1975 all soft drinks will be sold in non-returnable containers. In 1967 there were 3,403 soft drink bottling plants in this country (USA) employing 123,400 persons with a total payroll of \$727,100,000.

...A decline of 28.3% in the number of plants would amount to a drop in plants of 936, or a new total of 2,440 plants. The number of employees with a 15.6% decline would fall to 104,150. Using the 1967 payroll figure of \$5,892, the total loss in payroll would be \$113,421,000 yearly.

...A complete switch to throw-aways would also affect employment in food stores and other establishments selling soft drinks. Food chains estimate that it takes between $\frac{1}{4}$ and $\frac{1}{2}$ of a man to physically handle the sorting and related work connected with returnables.

...In addition there are thousands of warehousing jobs which would be adversely affected by a complete switchover to non-returnables.

If non-returnables increased, in Quebec alone, 150 bottling plants would become extinct and more than 3000 of the industry's 5000 workers would be out of work. The price of the non-returnable² would increase with the consumer absorbing the cost.

A switch back to returnable beverage containers would:

- increase employment in bottle manufacturing plants as more returnable bottles were produced to replace non-returnable bottles and cans.
- increase employment due to re-opening of small bottling plants which had to close because they could not afford the changeover to non-returnable bottles.
- increase employment in bottling plants for sorting and washing returnable bottles.
- increase employment in transportation because of additional bottles being returned to the bottlers.
- increase employment in stores carrying soft drinks for sorting and handling and dispersal of refunds.
- increase in employment due to the purchase of other goods with money saved by the consumer from returnable bottles.

Appendix II

To determine the views of the people of Hamilton on non-refundable beverage containers, the Solid Waste Research team sent out questionnaires and explanatory letters to eighty residents of the city, representing four different economic areas.

Five questionnaires were returned to us, 'Address Unknwn' so we assumed that seventy-five reached their destination. Thirty-two were returned to us completed, giving us a 43% return.

Of a population of 102 people in 32 households, there were a total of 355 bottles of soft drinks purchased per month. There was an average of 11 bottles per household and 3.5 per person.

The total number of bottles of wine and spirits purchased per month was 75.

The size of bottles in order of preference and the number of people who bought each type are:

26 oz (10); 28 oz (6); 32 oz (5); 30 oz (3); 16 oz (3);

40 oz (2); 10 oz (1); 24 oz (1); 7 oz (0).

60 % of the people bought returnables compared to 40% who bought non-returnables.

82% of those who bought returnables said they return the bottles to the store for a refund. 18% throw them in the garbage.

52% said they would buy more returnables if they were available at the store. 48% said they would not. Half of those who said they would not, said that they did not drink pop, or that they had home delivery, or that they felt there were enough returnables sold in the stores.

If soft drinks in non-returnable bottles became more expensive, 78% would buy returnables whereas 22% would buy non-returnables.

If a refund were given on all bottles, 84% would return bottles for a refund whereas 16% would not.

79% were in favour of a ban on non-returnable soft drink bottles. 21% were against a ban.

50% buy soft drinks in cans. 50% do not.

Most people throw used soft drink cans in the garbage. One person sends them to be recycled.

68% would return soft drink cans for a refund but 32% would not.

66% were in favour of a ban on soft drink cans and 34% were against it.

81% believed soft drink bottles were a cause of pollution, 19% did not.

80% believed soft drink cans were a cause of pollution, 20% did not.

90% said they would be willing to separate glass from their garbage if the city collected it separately.

The following are comments from questions 6, 8 and 14 in order of frequency.

- bottles contribute to the garbage problem (13)
- all bottles should be returned for the refund (8)
- recycling is a good thing (7)
- bottles contribute to the litter problem (3)
- there should be a higher deposit on returnable bottles (3)
- returnable bottles are a nuisance (3)
- cans are more convenient (2)
- children smash bottles on the street (2)
- jobs will be lost if soft drink cans are banned (2)
- all bottles and cans should be returnable (2)
- they should have a proper disposal system for bottles and cans (2)
- children will return bottles for refunds if adults don't (2)
- returnable bottles are a cause of litter as well as non-returnables (1)
- cost and time involved in separating is too great (1)
- more concerned with water and air pollution (1)
- animal excrement on lawns is a more serious cause of pollution (1)
- difficult to buy pop in returnable bottles (1)
- cans take up less room, decompose quicker, keep food and beverages longer than bottles, people cause litter (1)
- reclaimable materials should be collected separately (1)
- hope SWARU lives up to expectations (1)

Solid Waste Committee,
42 James St. N. Suite #503,
Lister Block,
Hamilton, Ont.

March 1, 1973

Dear Sir or Madam,

You have been chosen at random to complete the questionnaire which is enclosed with this letter.

It is very important that we know your views on this issue and we ask that you complete the questionnaire and return it by March 12, 1973. A self-addressed, stamped envelope is enclosed for your convenience.

It is hoped that your answers will give us an indication of how the people of Hamilton feel about solid waste management. The results of the questionnaires will be incorporated in a report to the Ministry of the Environment of the provincial government.

If you wish more information or have any further comments, please indicate this in question #16.

The questionnaire should take only about ten minutes to complete.

Yours truly,

Susan Walker
Al Marafon.

SW:AM:dl

1. On the average, how many bottles of soft drinks do you purchase per month?.....
2. How many bottles of spirits and wine do you purchase per month?.....
3. Do you purchase any special size of soft drink bottles, such as 7oz, 10oz, 12oz, 16oz, 26oz, 28oz, 32oz, 40oz, or other size?.....
4. Do you buy more soft drinks in
(a) returnable bottles?.....(b) non-returnable?.....
5. If you buy returnable soft drink bottles, do you return them to the store for a refund?.....
if no what do you do with them?

6. Would you buy more returnable soft drink bottles if they were available at your store?
yes _____ why? _____
no _____ why? _____
7. If soft drinks in non-returnable bottles became more expensive would you buy returnables _____ non-returnables _____?
8. Would you return all bottles if a refund were given (soft drink, liquor, wine)?
yes _____ why? _____
no _____ why? _____
9. Would you favour a ban on non-returnable bottles? _____
10. Do you buy canned soft drinks?.....
11. What do you do with used cans? _____
12. Would you return soft drink cans if a refund were given? _____
13. Would you favour a ban on non-returnable soft drink cans? _____
14. Do you believe that non-returnable soft drink bottles are a cause of pollution?.....
15. Do you believe that non-returnable soft drink cans are a cause of pollution?.....
16. How many people are there in your household?.....
17. Would you be willing to separate glass containers from your garbage if the city collected it?.....
18. Further comments?

Thank you

FOOTNOTES

Glass

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13. University of Oregon (1970-1971) p. 121-130
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15. University of Oregon (1970-1971) p. 141-150
16. University of Oregon (1970-1971) p. 151-160
17. University of Oregon (1970-1971) p. 161-170
18. University of Oregon (1970-1971) p. 171-180
19. University of Oregon (1970-1971) p. 181-190
20. University of Oregon (1970-1971) p. 191-200

PLASTICS

The percentage of plastics material in domestic and commercial waste is comparatively small, 1-3%, depending on whose figures you look at and in what urban area being studied. However its' usage in the field of packaging and in some industrial areas is rapidly increasing. It is the one material which is likely to rise by over 100% in the composition of solid waste by 1985. This is referring to plastics materials which have short-term as opposed to long-term uses, as in insulation and the interior of automobiles.

When compared with a material such as paper, plastics are of a very complex nature. As the materials we use daily become more complicated due to the various processes they undergo or the different chemicals they contain, the technology of handling and disposing of them has to be that much more complex in order to cope with them. This has not been the case. One example which will be looked at is Japan, where the percentage of plastics in solid waste was nearly 7% in 1968 and is expected to increase an additional 5% by 1975.¹

Because of their complexity, plastics can be hard to dispose of either by incineration or by sanitary landfill. They produce dense black smoke if not burned properly, neither disintegrate nor compact easily, and can clog or corrode incinerators. As its uses increase, what is to be done with it in terms of disposal methods? There are processes available (see solid waste disposal methods) but this section will deal with such criteria as its' complexity, biodegradability, packaging recyclability and methods of disposal that are being used to great extents today.

Plastics is a name applied to the family of materials based primarily on carbon chain polymers. Basically, they are part of the petroleum industry, derivatives of oil. One day's production of oil on a world-wide basis accounts for approximately one year's plastic requirement on a global scale.² Before the introduction of plastics, the oil refining fractions which are used as the material for plastics production were burned off. As mentioned, they are part of the petroleum industry and as such, can be used for heat or power if disposed of properly, which is usually not the case.

There are twelve basic types of plastics. Of the total plastics in collectible waste, approximately 50% is polyethylene (P.E.) in such forms as bottles for liquids and soaps, garbage bags, etc., 20% is polystyrene (P.S.) in such forms as coffee cups and lids, meat trays, etc., while 11% is polyvinyl chloride (PVC) such as bottles for hair shampoo and film for wrapping meat. These are the three major plastics found in solid waste collection, along with polypropylene and cellophane. All these materials have increased dramatically in usage because plastics have that quality of being inert, which is an excellent characteristic for packaging materials.

According to the Society of the Plastics Industry of Canada, plastics have done much to make for a cleaner, better, economical living.³ Most people would agree that plastics have done much to make for a better environment but plastics have also created problems for the better environment, which have yet to be solved. Unfortunately, because of their complex nature, plastics are also resistant to microorganisms which might otherwise attack the material which it contains, thus making degradation by some natural

mechanism almost impossible. Plastics have a very high molecular weight and a low surface area again making them useful in packaging.⁴ As a result of these characteristics, they create a problem which is noticed by everybody, attacked by everybody, and seen by some as the major waste problem facing us. This aspect is known as litter.

Litter makes up a minute percentage of the total solid waste picture but yet it has received the most attention in recent years. It seems to be the focal point of our throwaway society, seen only from an aesthetic viewpoint. The problem with plastics in this respect is that they just stay there. Come back next year and chances are that coffee cup you threw into the bush will still be there, in the same form. This problem has caused many individuals to spend much time and effort searching for ways to make plastics biodegradable.

Biodegradation is defined as

the entire phenomenon of microbial degradation including polymers. It hinges on the frequently observed fact that in the natural food cycle of the host of living creatures that inhabit the biosphere, a constant solubilization, directly or indirectly, quickly or ultimately, operates to reduce all materials to some state in which they can be utilized wholly or in part, as nutritional elements. 5

In simpler terms, it is a food sequence done not only by micro-organisms but by chemical, photochemical and thermal degradation, plus the insect world and scavengers to achieve the end.⁶

Individuals have tried many new processes to cause plastics to break down. Dr. James E. Guillet of the University of Toronto developed a material called 'ecolyte' which uses energy of natural sunlight to introduce into the polymer structure of a

plastic, a sensetizing group, which can absorb radiation to break down the chain structure of polymers. Criticisms of this process are that the cost of adding the sensitizer in the polymerization stage is too high to be worthwhile. Ron Hayter of Formpac Canada Ltd. claims that 'ecolyte' and another material introduced by Biodegradable Plastics Inc., which is a biodegradable concentrate for polystyrene, will gradually crumble into small pieces and become less visible but there has been no evidence presented to show that the next stage, biodegradation, follows. In a later reply from Dr. Guillet, he emphasizes that plastics can be designed to be biologically degradable, but there is some question as to whether or not this is a desirable feature. By-products of the degradation could be carbon dioxide, nitrates, methane gas and organic acids. Leachates could be formed which would seep through topsoil and enter the watershed system.⁷ Dr. Guillet states that 'ecolyte' is degradable only after exposure to outdoor sunlight and there is no problem of leaching because it does not biodegrade if it is buried.

Austin Science Associates of Austin, Texas have done extensive work on water degradable polymers. They have found interesting uses in the timely metering of pesticides such that a non-persistent pesticide can give extended protection at time of application. With pesticides, most pollution for agricultural chemicals comes in the runoff of drainage waters. Researchers in Austin feel that they can tie up chemicals in water degradable polymers, thus reducing the quantity of chemicals needed. If funding could be found they would like to work on a water degradable garbage bag, with several months to a year decay time.⁸

There are various other processes being carried on, but it

seems odd when you consider what a small proportion of solid waste litter is and what percentage of that is plastics. Instead of looking at litter, why not look at an overall view of packaging in the solid waste stream and what research could be carried on there.

PLASTICS IN PACKAGING

By 1976, plastics will probably account for 5% of all packaging.¹ This may seem like a small percentage but when you consider that plastic is a relative newcomer to the packaging field, it is quite a phenomenal growth. It was only in the early 1960's when polyethylene prices dropped that plastics in packaging began to grow.² Their dramatic growth can be easily accounted for. They are the perfect packaging material. Light in weight, they can be formed easily into any type of complex packaging needed. Fairly cheap, they represent a minimum expenditure of natural nonrenewable resources in their manufacture and also maintain their physical properties for long periods of time. Very stable, they do not contribute to the taste, odour or toxicity of the material they contain.³

Of the total plastics production, 20% alone is used for packaging, which also forms the largest plastic element in solid waste.⁴ Of the production of the plastics going into packaging, approximately 62% is polyethylene and polypropylene, 11% polystyrene, 8% polyvinyl chloride and 14% cellophane.⁵ An interesting figure is the 8% PVC, which researchers predict will move rapidly up to as high as 15%. You can see the growing trend to these more fire-resistant plastics. Resins for making PVC bottles amounted to 3.4% of the total plastic bottle production in the United States in 1966. By 1970 it had increased to 8.5%.⁶ PVC

and other plasticizers or additives usually contain halogens (chlorine and bromine) which when exposed to sufficient temperatures are released in gases to inhibit combustion. They appear in the form of hydrogen chloride and hydrogen bromide. These gases can form acids which will attack any corrodible metal parts of an incinerator. When burned in large volume, afterburners are needed to complete combustion. These increases of PVC necessitate better designed, more up-to-date incineration methods than what we have now.

All this might be changed though, with the introduction of such materials as Lopac, Barex 210 and XT polymers, all which have been tested as a substitute for PVC. They have the same characteristics in regard to gas permeation resistance, transparency, inertness and rigidity for which acrylic plastics are noted.⁷ Both Monsanto and Standard Oil of Ohio have experimented with these materials in bottle production. They expect the new bottle to alleviate the solid waste problem because it would be 1/8 as heavy as glass, have long shelf-life, will not break when dropped and can be incinerated without producing HCl.⁸ Other researchers say that they have found these bottles to produce cyanide when incinerated. Fortunately, cyanide is unstable and combines with other incinerator residues.⁹ However any widespread distribution of these materials in the near future is not foreseen because the resin supply for them is scarce and relatively expensive.

There has also been introduced onto the market the water degradable material or collagen which dissolves in boiling water. These are used in some laundry detergents but how widespread their

uses will be is uncertain.

As mentioned previously, packaging has become a highly innovative industry. From this research the consumer has also been introduced to the multi-material, which makes any economic feasibility of recycling or reusing these materials virtually hopeless. Such structures as copolymers, coextrusions and various coated and laminated materials are becoming common in packaging. Plastics these days are used to coat metals, paper, glass and in some cases rubber. Again you have man introducing these materials to make packages more attractive and durable but there is no method of coping with them once they fulfill their short-term usefulness. At the present time there is less than 10% of all packaging material being recycled.¹⁰

There are also other environmental hazards associated with plastic packaging materials. Plasticizers are ingredients which are added to plastics in the manufacturing process to increase flexibility and workability of plastics, a necessary characteristic for packaging. Polychlorinated Biphenols (PCB's) are a form of plasticizer additive to plastics. They have been found to disrupt normal breeding habits in certain animals such as wild fowl.¹¹ Many of the qualities which make PCB's attractive as industrial uses have contributed to their persistence in the environment. Their resistance to oxidation and hydrolysis make them more stable than DDT which also causes genetic disruption.¹² Of course, PCB's do not have to be used in plastics. For example, an oil spill found on the Speed River in Guelph in March contained a high amount of PCB. General Electric claimed responsibility for it but how much damage did it cause?¹³ Fortunately, Monsanto, the major producer of PCB in the United

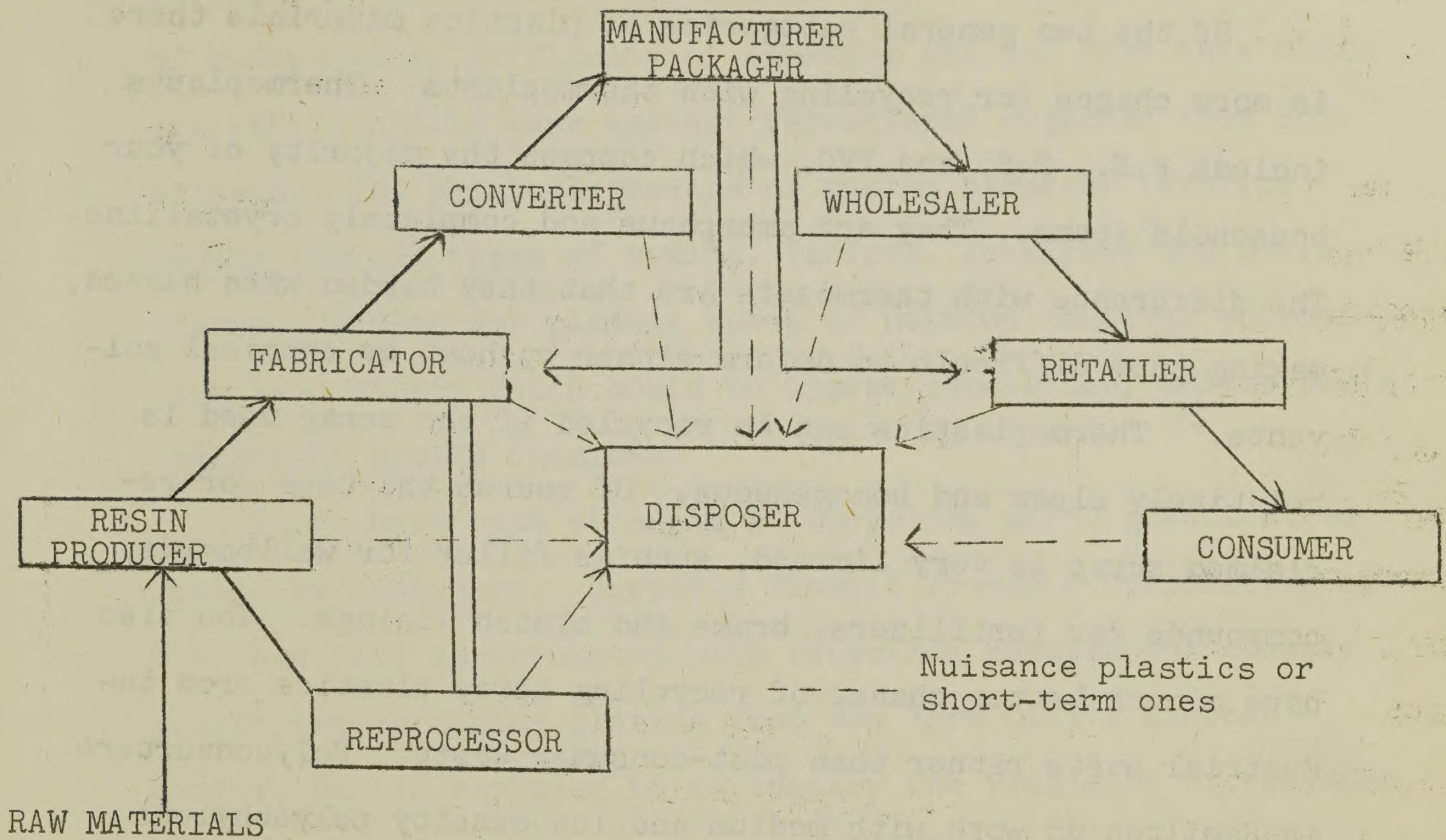
States, has supposedly recognized the potential harm it can cause the environment and has discontinued selling it to customers for use where disposal of final products cannot be controlled. I wonder if that applies in Canada?

As plastic packaging grows, you still have not solved the problem of collection and disposal. Assorted plastic packaging, when not compressed, occupies as much as 800 cubic feet per ton, in contrast to the approximately 30 cubic feet per ton density of completely compressed material.¹⁴ Now that we have collected all this material what do we do with it? Do we dump it, recycle it, incinerate it or try a new method such as pyrolysis?

SOLID WASTE DISPOSAL METHODS IN PLASTICS

From figure I, we can see that the plastics cycle involves many interrelated areas but all of them have one thing in common. Each area disposes of some plastics which usually wind up with the disposer as part of the total solid waste composition. The nuisance plastics are generated in most part from the consumer and the industrial sector. If we have to dispose of these plastics, should we try recycling them first?

First and foremost, nobody puts recycling first on the list of priorities in the solid waste field. In fact, most businessmen in industries (paper and metal) where recycling is viable, confess that volunteer groups are not good prospects because they're sporadic and cause the scrap market to fluctuate wildly. Any systematic business would feel that it is taking an abnormal risk in a recycling enterprise.¹ With regards to plastics, there is some recycling done, but it is mostly in-plant recycling.



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FIGURE I. THE PLASTICS CYCLE

The resin producer is responsible for determining the chemistry of the plastic product. The fabricator takes granulated resins and transforms them into a shaped article. The convertor then uses the fabricated items such as film to make for example, plastic bags. The manufacturer/packager then decides what type of plastic package he wishes to use for his product.

* Taken from "Design of Consumer Containers for Re-Use or Disposal" p. 90

Of the two general categories of plastics materials there is more chance for recycling with thermoplasts. Thermoplasts include P.E., P.S. and PVC, which compose the majority of your household items. They are amorphous and completely crystalline. The difference with thermosets are that they harden when heated, making them difficult to deform either by heat or chemical solvents.² Thermoplastics can be recycled if the scrap used is relatively clean and homogeneous. Of course the uses for reclaimed scrap is very limited, such as filler for wallboards, compounds for fertilizers, brake and clutch linings. You also have a much better chance of recycling scrap plastics from industrial waste rather than post-consumer waste. Polyconverters in Hamilton do work with medium and low density polyethylene but only so much work can be done because industrial supply is limited and the plastics must be of a certain type. Dow Chemical in the United States has experimented recently with mixing chlorinated polyethylene with high percentages of scrap plastics (75-85%) trying to compatibilize them into a material which has some value. Blends of some large volume plastics (P.E.) without segregation usually results in a product which has a cheesy, brittle nature.³ Hopefully that is being solved with the addition of chlorinated polyethylene in small amounts.

At the present time, little is being done in the way of actually recycling post-consumer waste. Many current separation mechanisms must overcome the difficulty of sorting plastics. This is compounded by the fact that paper is similar in specific gravity to plastics and the two can be readily mixed together. Even if it were possible to separate plastics from municipal

garbage, it would still be hard to recycle because of that lack of homogeneity, difficulty of cleaning and the fact that there are public health laws against reprocessed rejected food containers. The chemical process of making plastics involves adding certain types of resins, fillers, catalysts and plasticizers. Adding any plastic scrap of unknown chemical composition to a virgin batch would be almost impossible, unless Dow's experiment proves feasible.

There have been attempts at recycling waste plastics generated by consumers. Recycled Plastic Products Corporation of New York City experimented with recycling homogeneous plastic polystyrene drinking glasses from New York City's Lincoln Center, but in replying to an inquiry the President of Recycled Plastics Products stated that it was only an experiment and that it was more economically feasible to concentrate on industrial scrap waste.⁴ Part of the Burlington CCPC's program for separation of garbage was the separation of polystyrene egg cartons. Collection over approximately two years created a large amount of space being taken up and little to be done with it. Formpac Canada Ltd. had offered to take it from them and even gave them a press to compact the trays but it was too antiquated to be worth the effort and energy. Formpac never did send a truck to pick up the scrap and a two year collection of egg cartons would be up at the dump. Formpac had said the scrap would be used for such entities as plant bed trays for which a lot of their in-plant recycling is used. Another effort to recycle the plastics in solid waste took place in San Diego, California when the Golden Arrow Dairy decided to collect their

non-returnable high-density polyethylene milk bottles. Golden Arrow was going to grind them up for later use as plastic agricultural drainage tile. Unfortunately, the project failed because there was a state ordinance which made it clear that such drainage pipes had to utilize clean material generated from the manufacturer's own production.⁵

Thus any recycling of plastics on a large-scale is still years away, especially considering the low production costs of plastics. The technical and economic difficulties involved prohibit any widespread salvage at the moment, especially in mixed wastes.

Plastics can also create problems in the solid waste disposal methods that are in use today. Most up-to-date incinerators are designed to accept close to 10% of plastics in solid waste but how many up-to-date incinerators are there? In Toronto, five of the city's six incinerators are constantly exceeding the maximum allowed air abatement standards set by the provincial government. In Los Angeles, incineration was banned because of its contribution to air contaminants.⁶ The Federal Environment Protection Agency of the U.S. has stated that unless new disposal and reclamation technologies enabling plastics to be recycled are introduced, plastics could provide as much as 12% of the solid waste load in some areas by 1980.⁷ Most representatives of the plastics industry say that this is an extreme figure, but if recycling becomes viable with paper, this estimate could be fairly accurate. It must also be kept in mind that many plastics are being produced today for short-term usage. (Note Table I)

If we look at incineration of plastics in detail, the common problem mentioned is the burning of PVC. There is the possibility that the gains PVC has made in the plastic bottle market may have repercussions on incinerator corrosion and air pollution. The burning of large volumes of plastics does require injection of oxygen into the incinerator, an operation which is usually fueled by liquid natural gas, another commodity beginning to be used in short supply. When incinerated, plastics can also release more particulate matter of very minute and fine quality which is then removed by expensive control devices, such as precipitators. In antiquated incinerators, the high temperatures produced by the burning of plastics can clog incinerator grates and wear down the insides of them, causing high maintenance costs. With the burning of PVC, 40-50% of all hydrogen chloride found in incineration is produced.⁹ In a Report to the Society of the Plastics Industry, Professor Elmer Kaiser and Arrigo A. Carotti studied municipal incineration of refuse with 2 and 4% additions of four plastics.¹⁰ They found that adding PVC to the normal refuse increased chloride emission to 1990 ppm for the 2% addition and 3030 ppm for the 4% addition. This figure is meaningless until you look at the standards of other nations. It must be remembered that chloride combines with hydrogen to produce acid forming HCl in a gaseous state. West Germany established an ambient air quality standard of 0.5 ppm for a 30 minute average, with a maximum of 1.0 ppm for a 30 minute mean average. Russia has established a rather low ambient also. By other standards then, it is apparent that even the 2% PVC exceeds reasonable limits.¹¹ There is probably 0.5-1.0% in solid waste now, but like all plastics PVC is increasing rapidly.

There are also other problems in the burning of plastics which should be mentioned. The apparent reason for the ban in Los Angeles was that the high temperatures produced by incineration caused nitrous oxides to release that much more rapidly. Nitrous oxides can cause respiratory diseases and photochemical smog, something that Los Angeles has enough of. In another case, Dr. Richard Heimburg of Syracuse University stated that some of the damage to fresh water plant life can be attributed to the incinerated residue of PVC.¹² This is an extreme case of haphazard dumping but this might make the idea of ocean dumping of waste questionable.

When disposed of in landfills, plastics do not pose as many problems, because they do not decompose to evolve gases. Being inert is actually a plus in landfills but that does not really solve the problem of the depletion of resources, especially if one considers reusing plastics as a fuel. Another problem voiced by Fulmer and Testin in "Report on the Role of Plastics in Solid Waste" is that:

Some difficulty is experienced in compressing rigid containers. The dozers presently used in landfills do not exert sufficient pressure to rupture these containers. Much of the volume displaced by these containers is air. This increases the cost and lowers the quality of the landfill.

Hence in a landfill site it appears necessary to have a shredder or pulverizer for proper usage of it, especially if Connolly's estimate of 12% turns out to be true. If we look at it from a recycler's point of view, we probably dump over eight hours of production of oil (world-wide) in a year which could be used in the form of either energy or reprocessing. More will be said about this in the overall view of solid waste disposal methods.

JAPAN

As mentioned previously, Japan's situation has reached the point where the Japanese government is considering taking steps to regulate the production of plastics. In eight of Japan's ten largest cities plastics have been reported to have seriously damaged or corroded their incinerators. In four of these cities plastics have gone beyond the 10% acceptable level already. Problems include corrosion of some of the piping, weakening of some of the brickwork, plugging of grates, and in one case, partial corrosion of interior steel reinforced concrete walls. Contributing greatly to the problems of incineration are the high percentage of PVC in the refuse as well as glass reinforced plastics.¹³

The reason for the rapid growth of plastics in Japan is relatively simple. There is just not enough land area to accommodate large-scale forest technology. As a result, there is a scarcity of paper and wood products for the explosive type of economic growth that Japan has undergone. With the smaller land area than most industrial countries and relatively high population, there is more discretion in the choosing of landfill sites. In Japan, the number of cities, towns and villages requiring refuse incineration facilities is approximately 1300.¹⁴ With that much capital expenditure and the fact that many large petrochemical and plastics companies are constructing or planning to construct plants which produce synthetic paper from PE, PS, and polypropylene, the Japanese government is considering many avenues open to them. The Japanese Health and Welfare Ministry and the National Waste Management Congress are studying the following

proposals: i) that plastics production should be decreased, ii) that excessive packaging with plastics should be avoided, especially polystyrene foam, iii) that use of short-term plastics should be discontinued, iv) that the plastics industry should develop technology to treat plastics wastes and should produce more easily treatable plastics waste and that v) the Japanese Health and Welfare Ministry will not approve the introduction of additional plastic containers unless the producers can collect and treat the waste completely.¹⁵

All these proposals of course, represent quite a threat to the industries involved and they have taken some steps to rectify the situation. Burning ovens have been introduced having a capacity of 70 tons a day which burn plastics specifically and notably PVC. The most publicized new method is the Tezuka Kosan Process,¹⁶ which uses the idea of the auto compaction unit. Refuse is dehydrated to eliminate bacteria and then compressed to a hard stabilized mass. After being baled in chicken wire or covered with thin steel, these blocks can be used effectively in housing or in dikes for flood protection. This seems like an expensive method of getting rid of garbage and presupposes no opportunity to recycle any of the compressed material. Other innovative processes include using pyrolytic methods to produce carbon black or road paving materials. A pilot plant has been built in which plastic waste is melted, mingled with sludge discharged from sewage plants and molded into solid materials for civil or agricultural engineering and construction.¹⁷ Since the plastics are melted, there is no problem with smoke or gaseous emissions. Apparently the material is softer than ferro-

concrete but harder than a coreless concrete block. We also have the Japan Steel Works Process in which municipal waste goes through a system which separates ferrous metals, and then crushes, washes and dries the remaining materials. Upgrading additives are introduced. Further size reduction yields a reprocessed plastics 'compound' which is then fed into extruders for the production of profile products or to a pelletizing extruder for the production of molding pellets.¹⁸

As you can see, there is much research and processes being evolved, but only after industry was forced into it.

The throwaway system is one aspect of the everchanging values of our society, and I think there can be no doubt in anybody's mind that plastics are an important part of that throwaway system. However, to think of imposing a ban on plastics production is ludicrous because they are an extremely useful material. It will be necessary to plan for what will happen in the next decade in relation to plastics in waste disposal. Government alone cannot do it. It requires interaction among industry, government and the consumer. Recycling of waste plastics has of yet little commercial value but should we always view recycling in terms of economics? In this respect, much more research should be carried on. Plastics can be used very efficiently in modern incinerators to produce energy, which it was in its original state. In the end, as our oil resources decline and the use of plastics increase, there will come a time when it will have to be decided whether we should use oil for production of plastics or for fuel, although they can be used for both with proper technology.

* Elapsed Time for Plastic Products to Reach Disposal Area

<u>Product</u>	<u>Estimated Life (Years)</u>
----------------	-------------------------------

A. Elapsed Time 0-5 Years

Production Loss	0
Packaging	1
Novelties	1
Photographic Film	1
Disposables (Dinnerware, hospital goods)	1
Construction Film	2
Footware	2
Apparel	4
Household Goods	5
Toys	5
Jewellery	5

B. 5-10 Years

Sporting Goods	7
Automotive	10
Phonograph Records	10
Luggage	10
Appliances	10
Furniture	10
Cameras	10

C. 11-30 Years

Wire and Cable	15
Business Machines	15
Electrical Equipment	15
Hardware	15
Instruments	15
Magnetic Tape	15
Construction	25

* Taken from Proceedings of the Solid Waste Resources Conference on "Design of Consumer Containers for Re-Use or Disposal". p.83

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PACKAGING

The packaging industry in our society is one characterized by explosive growth and very perceptive management. Its' growth can be attributed to both innovative research and sales, but also to man's inherent laziness. Today, our society places great emphasis on convenience articles. Man can develop such commodities as the flip-top box, pull-ring can and the push-button aerosol without bothering to think of what will happen to these products once they have fulfilled their short-term usefulness. Throw them into the garbage and forget about them. It is very easy to accept products that give you that little bit of convenience. However, is it worth the price that we have to pay in terms of the depletion of the natural resources that are exploited in order to make these products? As our society becomes more affluent, the diversity of products become greater and our dumps get larger. The result of all this is that packaging¹ now accounts for between 60-70% of domestic and municipal waste. Of the total packaging waste, 70% is "thrown away" by the consumer,² and although man has been so inventive in developing packaging materials, he has not yet developed a feasible method of disposing of it.

North America is truly experiencing the era of "convenience packaging". Today, the average grocery store carries approximately 8,000 separate items. Within the next decade, an estimated 57% increase in the number of dry grocery products alone will occur with a phenomenal 125% increase in frozen food packaging.³

In a speech to the Battelle Memorial Institute in 1971, Judd H. Alexander of the American Can Company said:

Paper has played a key role in the packaging and distribution self-service revolution which has, in just one generation, dropped the relative price of food by $\frac{1}{2}$ to 17% of disposal income, quadrupled the number of items available to the shopper's choice in the supermarket, and cut by half the time spent by homemakers in food preparation. ⁴

In Canada alone our rate of consumption increases at 7% per year, while the rate of population increases at 4% per year. In eighteen years we will consume twice as much as today, but our population will not have increased even by one-half. ⁵

It is forecast that by 1976, 73 million tons of packaging materials will be used each year in the U.S. -- at a breakdown of more than 661 pounds/person/year. 2001 may well find man living amidst a gargantuan pile of garbage. If each man, woman and child continues at his present frenetic rate, he will then be "throwing away" 900 pounds of packaging waste each year. ⁶ Moreover, by 1976 paper and paperboard products will dominate the packaging field with 57% of the total on a tonnage basis. The remaining constituents of solid waste will include glass 18%, metals 13%, wood 7% and plastics ⁷ 5%.

As our society becomes more affluent, there seems to be less personal contact. In this report, packaging has taken the place of the sales clerk. Self-service merchandising also accounts for the tremendous growth. Just look at you local supermarket. The packages that have creative designs and shapes attract your attention and perhaps cause you to buy the product just because you like the package. Of course, this leads to the phenomenon known as overpackaging. Products are covered two to three times with various materials to make them more durable, even though they are classified as having short-term usage. As an example of overpackaging, let us consider

cosmetics. For every dollar spent on cosmetics, approximately 12.7 cents is on the packaging alone.⁸ This figure is an aggregate one, representing the percentages for all types, including premium priced ones. It is generally accepted that total packaging costs amount to about $\frac{3}{4}$ more than the cost of materials and machinery.⁹ The average American family is taxed about \$190 annually, or \$16 per month for containers which almost invariably end up in the garbage.¹⁰ It is the consumer who pays the costs of packaging products, ranging from 1.4% to 40% and more of the manufacturer's selling prices.¹¹ Considering that as much as 90% of the cost of wastepaper is involved in the collecting, sorting and transporting of the material would this same consumer be willing to pay an equal percentage for conservation concerns as he does for convenience?

A proliferation of package differentiation greets the consumer's eye and accounts largely for the high degree of impulse buying. As it is, marketing tests have determined that the amount of time the average shopper (generally a woman) gives to a product decision is about 4 seconds.

There is also a trend towards smaller containers, which again are being promoted on the basis of convenience. This means less efficient use of natural resources. In the container industry for example, a twelve ounce container measured by the Environmental Protection Administration of New York City was found to have 10.3% less efficient surface area to volume of contents ratio than the larger sixteen ounce fluid container.¹² This would mean very little if the containers were returnable, but the public has been educated by the advertising industry to regard convenience as meaning conveniently disposable. Many argue that you cannot reduce the size

volume of packaging, that insistence on excessive bulk, because there is struggle known as competition and you have to do it to keep your share of the market.

It is interesting to note the six main packaging requirements if an adequate self-selling job is to be accomplished:¹³

1. The package must attract attention.
2. The package must tell the product story.
3. The package must build confidence.
4. The package must look clean and sanitary.
5. The package must be convenient to handle, to carry out of the store and to use.
6. The package must look like good value.

Note that neither consideration of the recycling issue nor any attempt to reduce the overall costs or the amount of material used in packaging has been undertaken. The above challenges are, of course, directly related to any other method of personal selling.

1. The approach and greeting.
2. Determining the customer's needs.
3. Presenting the merchandise effectively.
4. Meeting objections.
5. Closing the sale.
6. Retaining good will after the sale.

Those who make, use and sell packaging items like to use that term competition and also free enterprise, wanting no government interference hindering their production of billions of containers and packages. However, when these short-term products become waste many feel that the government should provide the finance and do the research to develop methods to cope with that fast growing problem of urban areas called garbage. We think differently.

Changes can and should be effected in the packaging field. Products should not be designed as one-way disposables. Ideally, products should be durable, functional and easily recyclable. While these qualities alone should sell the merchandise, the secondary elements of style, status, sex and of course, obsolescence in one form or another, are often the important determining factors. Measures must be taken to develop packaging materials which either are rapidly and safely degradable, or are more suitably designed for reuse, reprocessing or reclamation. Product recyclability must be co-ordinated with all facets of merchandising: advertising, transportation, handling, retailing, etc. Prohibition of excess, standardization of sizes and materials are other areas of concern. Finally, the federal and provincial consumer affairs departments should, in conjunction with industry, design packaging materials that are readily recyclable and thereby lessen the burden on re-
 14
 source supplies and disposal facilities.

General Recommendations

1. Consumer research is necessary to determine the quality of individual concerns. Effective education is necessary, so that the consumer can understand the problem, be better able to choose the kinds of products he wants and hopefully, begin to participate in mitigating the solid waste problem.
2. From the opposing arena, the packaging industry should institute a communications programme to educate and motivate the consumer.
3. Consumer communications should be centralized and coordinated on a national basis.

4. Products should be visually marked if certain minimum amounts of recycled materials have been used in packaging, thereby encouraging and allowing the consumer the option of choice.

Objectives for Packaging Materials

- 1) Reduce amount of packaging materials used.
- 2) Reduce technical difficulty involved in processing packaging wastes for recycling and recovery.
- 3) Reduce the destruction of valuable natural resources from which packages are made.
- 4) Provide resources to manage wastes resulting from packaging materials.

*All these have underlying objectives of providing systems that will recycle solid waste material.

Design of package can be related to disposal problems

- 1) Cut it at source through better choice of materials, regard for disposability, biodegradability; recycling and smaller bulk.
- 2) Cut difficulties of collection through a structured design for compactability and by enlisting the cooperation of consumers through better motivation.
- 3) To cut disposal problems by exercising judgement in the use of hard-to-dispose of combinations and laminations.
- 4) Criteria of package development should consider:
 - a) product compactability
 - b) machinability
 - c) product protection
 - d) distribution ability
 - e) consumer convenience
 - f) disposability

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THE TASK FORCE ON SOLID WASTE

In the fall of 1972, the Ontario Minister of the Environment, James Auld, appointed a Task Force on Solid Waste (better known as the Total Waste Task Force) to develop recommendations to the Minister to produce solutions to problems created by the constantly increasing generation of solid waste.

Representatives were appointed from the following associations to sit on the Task Force:

Consumers Association
 Conservation Council of Ontario
 Pollution Probe
 Packaging Association of Canada
 Metal Container Manufacturers Advisory Council
 Glass Container Council of Canada
 Canadian Secondary Materials Association
 Society of Plastics Industry of Canada
 Canadian Pulp and Paper Association
 City Engineers Association
 Association of Municipalities of Ontario
 Ministry of the Environment

In the first meeting, the Task Force was acquainted with the three paths along which true solutions might be developed:

- 1) Reduction of the amount of waste generated
- 2) Return and re-use of articles and materials without entry into the disposal system
- 3) Adoption of significant policies providing for salvage of material and energy, and large scale recycling of materials.

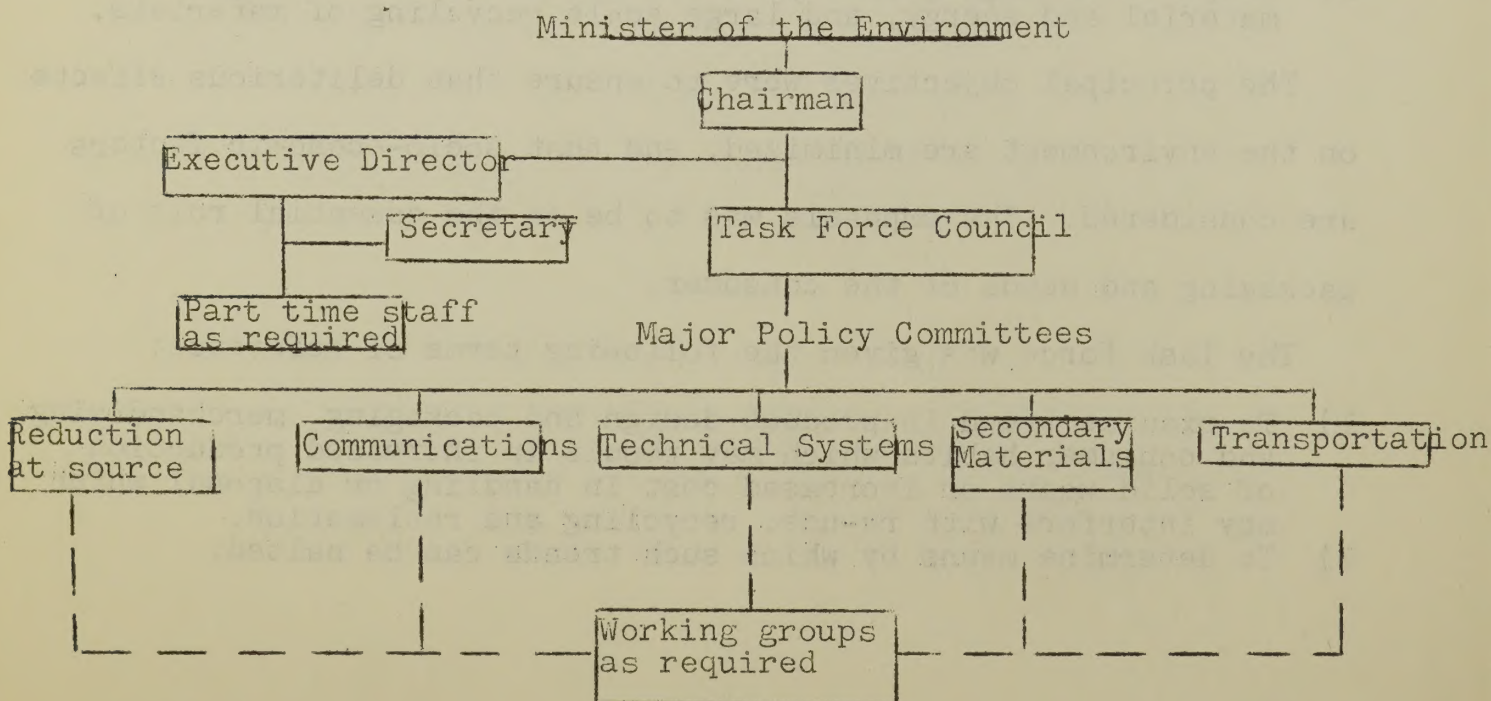
The principal objectives were to ensure that deleterious effects on the environment are minimized, and that socio-economic factors are considered. The emphasis was to be on the essential role of packaging and needs of the consumer.

The Task Force was given the following terms of reference:

- 1) To examine trend in product design and packaging, merchandising and consumer habits which may result in increased production of solid waste or increased cost in handling or disposal which may interfere with re-use, recycling and reclamation.
- 2) To determine means by which such trends can be halted.

- 3) To determine the most effective means by which all levels of government, industry, and the public can participate to attain the objectives.
- 4) To obtain and evaluate information on alternative waste management systems.
- 5) To determine the requirements for research and development projects and make recommendations for programs of research and development, with the emphasis on the recovery of energy or materials for re-use and conservation of resources.
- 6) To examine the status of secondary materials industries and their capacity for dealing with an increased flow of materials and to determine methods to increase this capacity.
- 7) To examine the capability of industry to utilize reclaimed material and recommend measure to improve utilization.
- 8) To examine the constraints imposed by transportation costs on use of waste and reclaimed materials, and to prepare measures designed to remove the imbalance over virgin materials.
- 9) To examine, evaluate and make recommendations on any other matter considered by the Task Force as necessary for achievement of the objectives.
- 10) To examine existing legislative instruments and make recommendations respecting amendments or new measures.
- 11) To make the report available to the Minister of the Environment within nine months.

The following proposal for achieving the major objectives was introduced by Mr. Williamson, representative of the Ministry of the Environment, but in spite of its merit, its procedures were never adopted.



The Task Force was to ensure the establishment of working groups to provide for examination of all essential aspects and information. the role of the Task Force in the working groups was to assign the general terms of reference and to examine reports submitted by the working groups.

Mr. Auld said that the Task Force should establish a few priorities and begin with simpler tasks. He suggested that two working groups be assigned; the Beverage Packaging Working Group, concerned with non-returnable beverage containers, and the Milk Packaging Working Group, concerned with the non-returnable milk containers. It is believed that Mr. Auld suggested that these two groups in particular be established because he had been continually pressured by the public to make an immediate decision on these issues. Even Mr. Auld's predecessor, Environment Minister Kerr, promised legislation on the beverage container issue but this was delayed because he wished to research the problem further. Mr. Auld unwilling to make such a controversial decision himself, set up the Beverage Working Group to make the decision for him.

In July, 1972, the Ontario government banned the non-returnable milk jug introduced by Dominion Dairies Ltd. In August, the government received a proposal from Dominion Dairies asking that the ban be lifted and recycling depots for plastic packaging be set up. The proposal was refused, but Auld promised to refer the issue to the Task Force and the Milk Packaging Working Group came into being.

The terms of reference for the working groups were laid out by the Task Force and the chairmen were appointed. The members of the working groups were to be selected from individuals or groups which are identifiable with environmental matters, for the most part,

however, members of the industry were selected.

One of the organizations involved in the Task Force, Pollution Probe, stated that they believed the Task Force itself was not tackling general policy questions or specific issues. They recommended that instead of only two working groups, the five policy groups as suggested by Mr. Williamson be organized. The possibility of forming other working groups was discussed, but some of the members of the Task Force felt that this would place too heavy a demand on them.

At a meeting in April, the Milk Packaging Working Group said that its report to the Task Force would be ready by the end of June. The Beverage Packaging Working Group said that its report might be ready for the end of June. They had received 50-60 briefs from the public and were assessing these. They felt that they would probably be submitting a majority and a minority report to the Task Force. The possibility of forming two more groups, the Resource Recovery working group and the Reduction of Waste at Source Working Group was discussed. This will be discussed further at the next meeting.

There have been several complaints from various people and groups about the efficiency of the Task Force on Solid Waste. Many people feel after six months, the Task Force should be concerned with more than the problem of beverage containers, especially since the terms of reference are so broad. Some feel that the Task Force and the Working Groups are heavily biased in favour of industry. Some feel that in setting up the Task Force, Auld's main concern was to get all opposing groups together in confidential meetings rather than opposing each other publically. And most,

including Ontario N.D.P. leader Steven Lewis and Liberal leader Robert Nixon believe that the Task Force has not met frequently enough to accomplish anything.

The Task Force has made one statement to the effect that all municipalities be encouraged to consider recycling proposals as an alternative to landfill. It is generally felt that the Beverage Packaging Working Group will come up with recommendations favouring a ban on non-returnable beverage containers.

Mr. Auld "has considered and is considering ways of ending it (the Task Force) and starting a new smaller group that will be more effective in aiding the long-range planning of solid waste disposal." ¹

Let us hope that any revised Task Force will be composed of members who are less biased in favour of industry and more concerned with the environment. They should be willing to research all of the areas outlined in the terms of reference and come up with some definite recommendations to help solve the garbage problems in Ontario. Most important, they should act according to the wishes of the public, not only those of the Minister of the Environment.

OVERALL RECOMMENDATIONS

- 1) The Department of the Environment should establish a committee to gather information on all recycling projects and users of reclaimed materials, act as advisor and provide initial financial support to any group desiring to establish a recycling project. This committee should also act as coordinator between industry and any groups in establishing future recycling projects.
- 2) Federal and Provincial governments should actively encourage industry to expand the use of post-consumer waste.
- 3) Preferential tax treatment should be provided for recycled materials to stimulate recycling markets.
- 4) Freight rates should be restructured to give recycled materials equality with primary materials.
- 5) Government and industry purchasing policies should be revised to increase the use of recycled materials.
- 6) Research into developing new ways and methods of separating and re-using solid waste should be conducted and industry should be encouraged to participate as much as possible.
- 7) Consumers should be made aware of the high standards of recycled materials and the social value of such purchases. They should be encouraged to buy products made with recycled materials.
- 8) That all municipalities be encouraged to consider recycling proposals as a method of waste disposal, and an alternative to landfill.
- 9) That all excess packaging be eliminated and that containers be not only functional but easily recyclable or disposable.
- 10) That a logos symbol be accepted to designate the use of secondary waste materials and that the percentage of same be acknowledged.

OVERALL RECOMMENDATIONS

- 1) The Government of the Environment should establish a committee to gather information on all recycling projects and areas of need, to provide technical and financial assistance, and to provide support to any group desiring to establish a recycling project. This committee should also act as a coordinator between industry and any groups in establishing future recycling projects.
- 2) Federal and Provincial governments should actively encourage industry to expand the use of non-hazardous waste.
- 3) Preferential tax treatment should be provided for recycled materials to stimulate recycling markets.
- 4) Freight rates should be restructured to give recycled materials equality with primary materials.
- 5) Government and industry marketing policies should be revised to increase the use of recycled materials.
- 6) Research into developing new ways and methods of separating and re-using solid waste should be conducted and industry should be encouraged to participate as much as possible.
- 7) Government should be made aware of the high standards of recycled materials and the social value of such purchases. They should be encouraged to buy products made with recycled materials.
- 8) That all municipalities be encouraged to consider recycling proposals as a method of waste disposal, and an alternative to landfill.
- 9) That all excess packaging be eliminated and that containers be not only functional but easily recyclable or disposable.
- 10) That a logo symbol be adopted to designate the use of second-hand waste materials and that the percentage of same be acknowledged

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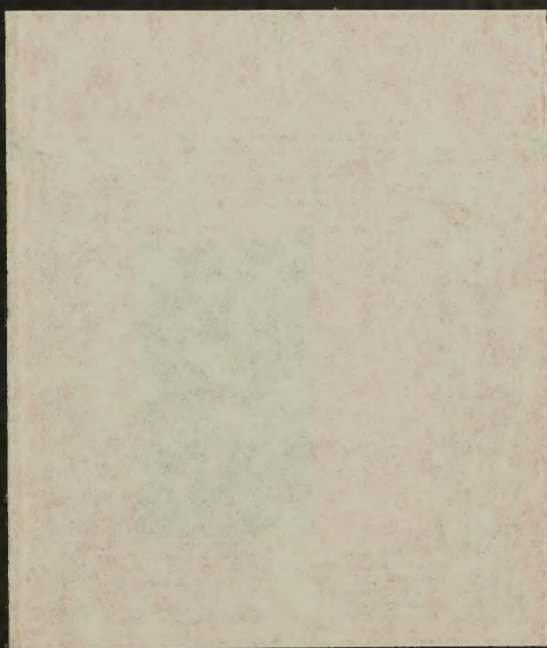
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